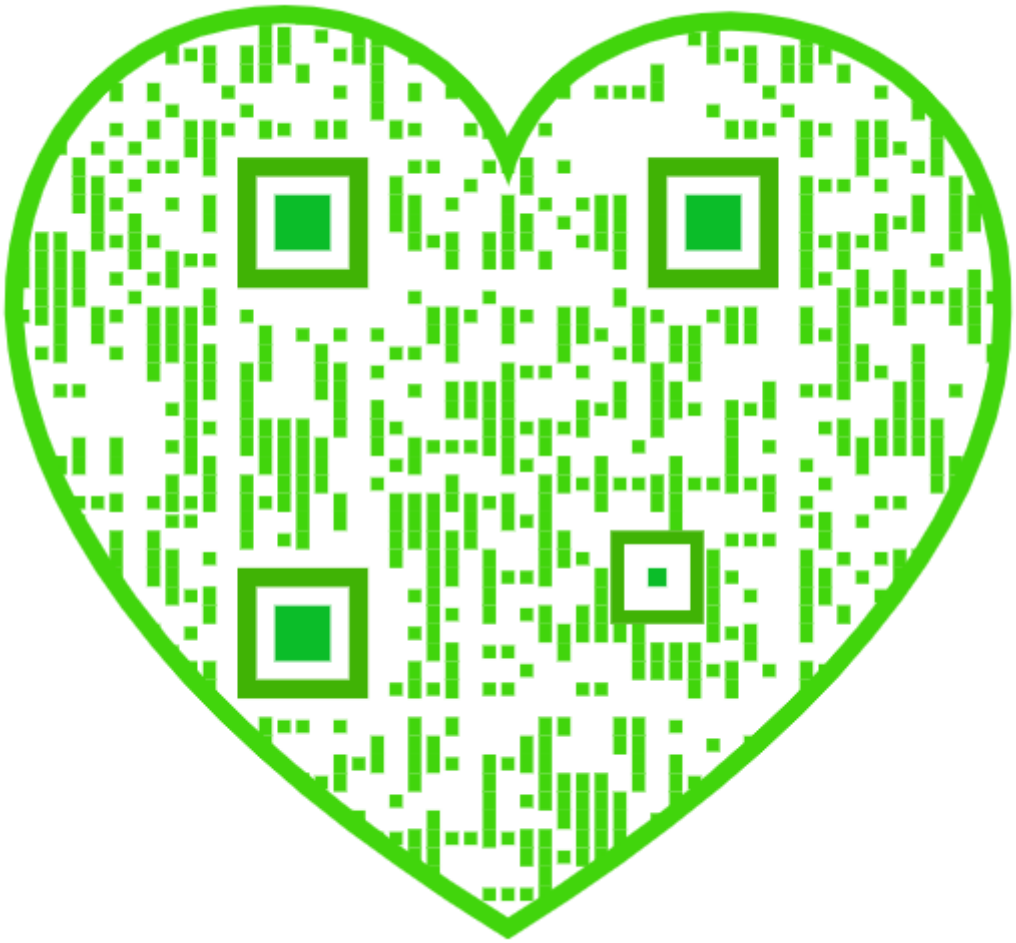
UNIV. OF
TORONTO
LIBRARY



regular doors. And the framework of these main doors must be substantially secured in brick or stone laid in mortar or cement unless permitted to the contrary in writing by the inspector.

All permanent overcasts shall be substantially built of such material and of such strength as circumstances may require.

Ques. 23.—State the requirements of the mine law in reference to air measurements, with records and reports of the same.

Ans.—The quantity of air in circulation shall be ascertained by an anemometer or other efficient instrument. The measurement shall be made by the inside foreman or his assistant once a week at the intake and return airways, at or near the face of each gangway, and at the nearest cross-heading to the face of inside and outside breasts which are working, and these measurements shall be entered in the report book. A monthly statement of these measurements with the number of persons employed in each district or split shall be sent the inspector before the 12th day of each month. All ventilators must be provided with some device for recording their speed or the ventilating pressure each hour, such data being preserved at the mine for a period of 3 months. Cross-headings must not be more than 60 feet apart.

Ques. 24.—What instruments are necessary or beneficial for a mine inspector to determine the atmospheric condition in a mine? Give name of each and the purpose for which it is used.

Ans.—(1) An anemometer to determine the velocity of the air. (2) A watch to determine the number of seconds during which the anemometer has been registering. (3) A tape to measure the dimensions of the airway where the anemometer was used. (4) A water gauge (customarily in place in each mine) to measure the ventilating pressure. (5) A thermometer to measure the temperature of the air. (6) A barometer to measure the pressure of the air. (7) A good safety lamp to examine the workings for methane. The uses of these instruments have repeatedly been described in these columns within recent months.

Ques. 25.—Name and describe the different gases met with in anthracite mines, giving their symbols, familiar names, specific gravity, where they are found, and their effect upon life and health.

Ans.—Methane; symbol CH_4, also called marsh gas, light carburetted hydrogen, firedamp, or merely gas. Specific gravity, .559. It is found near the roof of flat workings and at the face of rise workings. It is not poisonous but in sufficient quantities causes death by suffocation by diminishing the proper proportion of oxygen in the air. Chiefly dangerous by reason of its explosive properties when mixed with the proper amount of air.

Carbon dioxide; symbol CO_2, also known as carbonic acid, or blackdamp. Specific gravity, 1.529. It is found near the floor of flat workings and at the face of dip workings. It is not poisonous but causes death from suffocation if in sufficient quantity to materially reduce the proportion of oxygen in the air below its normal amount.

Carbon monoxide; symbol CO, also known as carbonic oxide, or whitedamp. Specific gravity, .967. Rarely found in anthracite mines except as a product of combustion from gob fires, from the explosion of certain classes of powder, and in the afterdamp of an explosion. A highly poisonous gas, replacing the oxygen in the blood. It is also explosive.

Hydrogen sulphide; symbol, H_2S, also known as sulphuretted hydrogen or stinkdamp. Specific gravity, 1.191. Found near the floor of flat workings or the face of those going to the dip. It is explosive and is highly poisonous like carbon monoxide.

Hydrogen and ethylene, the latter known as ethene or olefiant gas, are very rarely met in mines. Their symbols are H and C_2H_4 and their specific gravities, .069 and .970, respectively. They are found near the roof of flat workings and at the face of rise workings associated with methane. They are highly explosive but are not poisonous, producing death by suffocation if in large enough quantity.

Nitrogen; symbol N, specific gravity, .971, while always present as the chief constituent of air, is sometimes given off by coal and by the explosion of some types of powder. It is not poisonous but produces death by suffocation by reducing the oxygen content of the air. It will be found near the roof where the ventilation is sluggish.

Oxygen; symbol O, specific gravity 1.106, while common in the air, of which it forms about 20 per cent., is rarely found in a free state in mines. It is not poisonous and is the only supporter of life and combustion.

Ques. 26.—Give approximately and in numerical order the territory embraced in each of the inspection districts covered by this examining board.

Ans.—The mining law recognizes but seven inspection districts as follows: First District, Luzerne County with six inspectors; Second District, the counties of Lackawanna, Sullivan, Susquehanna, and Wayne, with six inspectors; Third District, Carbon County with one inspector; Fourth District, Schuylkill County with four inspectors; Fifth District, Northumberland County with two inspectors; Sixth District, Columbia County with one inspector; Seventh District, Dauphin County with one inspector. The Department of Mines has assigned each of these 21 inspectors a district the boundaries of which are not fixed by law nor do they appear in the reports of the department.

Ques. 27.—In a gangway with 8-foot collar, 12 feet spread and 7 feet clear of rail, we have the following anemometer records: 243, 261, 230, 252, 290, and 224 revolutions at different points in gangway, none of which are in the center, and 320 revolutions in the center of the gangway. (*a*) What is the ratio of the mean velocity to the maximum central velocity of the air-current? (*b*) What is the quantity of air passing per minute?

Ans.—(*a*) Assuming that these readings have been corrected for the instrumental error, the average velocity of the air will be equal to the sum of the individual readings divided by the number thereof, or $1,820 \div 7 = 260$ feet per minute. The ratio of the average to the maximum velocity will be $260 : 320 = 13 : 16 = 1 : 1.231$.

(*b*) The average width of the gangway is $(8+12) \div 2 = 10$ feet, from which the area equals $10 \times 7 = 70$ square feet, and the quantity of air passing equals $70 \times 260 = 18,200$ cubic feet per minute.

Ques. 28.—With a fan developing 30 horsepower at the fan, with a water gauge of 2.3 inches, but from which only 50 per cent. of useful effect is obtained; what quantity of air would be available?

Ans.—As the fan is developing but 50 per cent., or one-half its power in useful work, the net or actual horsepower acting on the air is but 15. Using the formula $q = \frac{u}{p}$, in which q equals the quantity of air in circulation in cubic feet per minute, u equals the units of work per minute, and p equals the pressure in pounds per square foot, we have

$$q = \frac{u}{p} = \frac{15 \times 33,000}{2.3 \times 5.2}$$

$= 41,388$ cubic feet per minute.

Ques. 29.—Calculate the quantity of air passing per minute, the pressure in pounds per square foot, the water gauge, and horsepower, under the following conditions: Airway 5 ft. × 8 ft., 4,000 feet long. Anemometer reading equals 200.

Ans.—The quantity of air passing is equal to $5 \times 8 \times 200 = 8,000$ cubic feet of air per minute.

$$\text{The pressure} = p = \frac{k\,s\,v^2}{a}$$

$$= \frac{.0000000217 \times 400 \times 26 \times 200^2}{40}$$

$= 2.257$ lbs.

$$\text{The water gauge} = i = \frac{p}{5.2} = \frac{2.257}{5.2}$$

$= .44$ in.

$$\text{The horsepower} = h = \frac{q\,p}{33,000}$$

$$= \frac{8,000 \times 2.257}{33,000} = .547 \text{ Hp.}$$

Ques. 30.—In a 12-inch column pipe 450 feet long on 42-degree pitch: (*a*) What would be the pressure per square inch at bottom? (*b*) What would be the total weight of water in tons?

Ans.—(*a*) The vertical height of the top of the pipe above its bottom is equal to $450 \times \sin 42° = 450 \times .66913 = 301.11$ feet.

Assuming the weight of a column of water 1 foot high and 1 square inch in area to be .434 pound, the pressure per square inch on the bottom of the pipe will be, $301.11 \times .434 = 130.68$ pounds.

(*b*) The area of the pipe equals $1^2 \times .7854 = .7854$ square feet. The volume of the pipe equals $.7854 \times 450 = 353.43$ cubic feet. Assuming the weight of a cubic foot of water to be 62.4 pounds, the weight of the water in the pipe equals $(353.43 \times 62.4) \div 2,000 = 11.027$ tons.

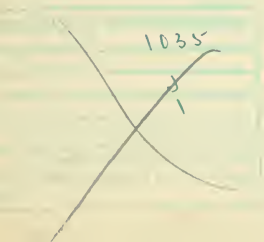
Ques. 31.—If elected State Mine Inspector and assigned to a district which included a large colliery with which you were entirely unfamiliar, how would you proceed to make your first inspection?

Ans.—The work may be divided into four parts.

(*A*) Before leaving home: (1) Examine the reports of your predecessor in office for information as to the size of the mine, nature and kind of equipment, points he considered worthy of special notice, such as new construction, squeezes, mine fires, existence of bodies of standing water, approach of gangways to abandoned workings or to a property line, and make a note of these and the names and positions of the officials you wish to see. (2) Note if a mine map has been furnished and if it is on the scale and contains the information required by law. Note any points gathered from the map that appear to require explanation or investigation. See if the map has been brought up to date as required by law. (3) Note if the office records contain the necessary reports of air measurements, boiler inspection, steam gauge inspection, etc. (4) Note if there have been any complaints filed against any officials or employes for violation of the mine law and if these have been satisfied or are still pending. (5) Take necessary notebooks, anemometers, tape, etc.

(*B*) At the mine office: (1) Introduce yourself to the clerk and ask for the manager, superintendent, or mine foreman. (2) See if an up-to-date mine map is on file in the office, and get an explanation of any underground or surface features you do not understand. (3) Note if the map shows that the proper pillars are left between adjacent workings or abandoned mines, etc. (4) Inquire as to the number of underground employes and compare this with the air measurements in order to learn if each is receiving the proper amount of air. Note if the foremen, etc., have the proper certificates. (5) Note if the proper air measurements, reports upon abandoned workings, etc., are entered in the right manner in the right books. (6) If, after inspecting the plant, there is reason to believe that any of the boys are below the age at which they are legally permitted to work, inquire for their birth, or age, certificates. (7) See if the proper duplicates of all reports required to be furnished the inspector are on file. (8) If any legal matters are pending concerning alleged violations of the mine law, investigate their status.

(*C*) Before descending the mine: (1) If possible and from some nearby elevation get a general view of the plant. Note if it is neat and tidy or dirty and disorderly. An untidy plant indicates careless and indifferent management which is very apt to be reflected in the manner in which the provisions of the mine law are carried out. At a dirty, neglected looking plant, take nothing for granted but investigate everything. Dirt covers a multitude of defects. (2) Note if a copy or proper abstract of the mine laws and rules is properly posted and is legible. (3) Note if the last report of the State Mine Inspector is properly posted. (4) In all places where young boys are employed see if the list of ages is posted. If any boy appears below legal working age, take his name, and even if his name is on the posted list, investigate


1035

Technol
Mym Dep
Tech
C

The Colliery Engineer

Formerly
Mines and Minerals

VOLUME XXXIV

August 1913, to July 1914

SCRANTON, PA.
INTERNATIONAL TEXTBOOK CO.
1914

134814
22/10/14

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK CO.
ALL RIGHTS RESERVED

Digitized by the Internet Archive
in 2008 with funding from
Microsoft Corporation

http://www.archive.org/details/collieryengineer34londuoft

INDEX

INDEX A—Authors, Subjects, and Titles of Articles

(Separate Indexes of "Book Reviews," "Personals and Obituaries," "Catalogs Received," and "Trade Notices" follow "Index A")

Page

ABILITY OF ACTYLENE FLAME TO SHOW PRESENCE OF DANGEROUS GASES 239
Acetylene, Explosion Not Caused by..... 702
Acetylene Flame to Show Presence of Dangerous Gases 239
Acetylene Lamp, Defense of..... 179
Acetylene Lamp Difficulties..... 109
Acetylene Lamps 180
Acetylene Lamps in Coal Mines..... 2
Acetylene Lamps in Coal Mines, Experiments by Price and Menner..... 49
Accidents, Coal Mining Comparatively Safe 572
Accidents, Illustrated by Moving Pictures 65
Accidents in Great Britain, 1912, Mine..... 238
Accidents, Prevention of..... 573
Accidents, Prevention of Haulage..... 169
Accidents, Rules for Prevention of..... 429
Accident, Strange 765
Accident, Unusual 228
Accident? What is a Fatal Mine..... 329
Accident with Benzole Locomotive..... 288
Accounting, Mine 362
Ackroyd & Best, Ltd., Belgian Test of Hailwood Lamps 456
Acton, Alabama, Explosion 440
Aczol Process of Preserving Mine Timbers 674
Advances in Permissible Explosives..... 111
Advantages of Machine Mining..... 435
Advantages of Steel Mine Cars..... 172
After the Fire 201
Air Compression, Electro-Pneumatic..... 681
Air Compressors, Care and Lubrication of.. 104
Air Compressor, Oil Driven..... 778
Air Cylinder Lubrication..... 347
Air Hammer vs. Rotary Drills..... 554
Air of its Danger, Robbing Mine..... 659
Air Receivers, Oil in..... 768
Alabama Coal Export..... 199
Alabama Coal Operators' Association, July, 1913, Meeting 69
Alabama, Moistening Coal Dust, Safety Pamphlet 559
Alaska Coal Markets..... 371
Alaska, Conditions Affecting Mining..... 481
Alaska, "Mountains of High-Grade Coal".. 589
Alaska, Prospecting Bering River Coal Field 347
Alaska, Test of Bering River Coal Unfavorable 395
Alberta, Coal Fields of Jasper Park..... 399
Alberta Mining Law, Change in..... 360
Alberta, Smoky River Coal Field..... 346
Alberta, Qualifications for Certificate in, 635, 700
Alford, Newell G., Western Kentucky Coal Mines 414
American Blower Co., Ventura Fans..... 194
American Coal Dust Precautions..... 739
American Engine and Electric Co., Four-Cylinder Triple Expansion Engine..... 712
American Institute of Mining Engineers... 654
American Institute of Mining Engineers, Anthracite Section 395
A. I. M. F., Coal and Coke Section of..... 570
American Mine Safety Association..... 96

Page

American Mine Safety Association Contest, 1913 207
American Mining Congress..21, 65, 67, 131, 263
American Mining Congress, October, 1913.. 290
American Peat Society..... 37
American Society of Mechanical Engineers, New Journal 408
Ammonia Bombs for Extinguishing Fire.... 180
Analyses of Mine Explosions..... 435
Analyses, Value of Coal..... 242
Analysis of Coke 529
Anderson, Arvid R., Storage-Battery Locomotive 146
Anderson, W. K., Pillar Drawing..... 313
Anemometer, New 327
Animal Haulage in Mines..... 139
Annual Safety Boosting Banquet..... 440
Anthracite, Burning Low-Grade..... 567
Anthracite Companies Have Done, What the Large 132
Anthracite Conciliation Board..... 523
Anthracite Dust 588, 700
Anthracite Dust, Explosibility of..... 653
Anthracite Dust Explosive? Is..... 109
Anthracite in 1913, Output..... 767
Anthracite Mine Engineering..... 753
Anthracite Mine Cave Problem..... 264
Anthracite Region, Stripping in..... 655
Anthracite Seams, Depth and Thickness of 481
Anthracite Seventy Years Ago, Taxation of 306
Anthracite Shipments, June, 1914..... 760
Anthracite Supplies 658
Ash, Simon H., To Prevent Mine Doors Being Left Open..... 431
Ashworth, James, Auckland Park Colliery Explosion, 416—Report of English Explosions in Mines Committee, 92—Stone Dusting in Dusty Coal Mines..... 574
Auckland Park Colliery Explosion..... 416
Austrian Trial Gallery, Correction..... 617
Automatic Chute Stop 474
Automatic Mine Door at Seneca..... 360
Automobile at Coal Mines, The..... 770

BAIJOT, A. J., BENZINE LOCOMOTIVES 623
Bailey, William, Location of Regulator.... 39
Baldwin-Westinghouse, Largest Mine Locomotive Ever Built, 325—Locomotive for Low Coal, 715—Locomotive Record at Scalp Level 521
Barlow Medal 767
Barker, W. H., Pumping..... 513
Barclay, Andrew, Qualifications for Certificate in Alberta 635
Barium Chloride Hardening..... 241
Basic Coke 409
Basic Coke 725
Bath House, Mount Pleasant..... 354
"Battleship," Poem 386
Beard-Mackie Safety Lamps, Test of..... 108
Bear Valley Shaft, New Rock Plane..... 686
Beaver, Gus, Haulage Problem..... 635
Belgian Coal-Dust Precautions..... 599
Belgian Coal Field, New..... 188

Page

Belgian Haulage Tests..... 686
Belgian Test of Hailwood Lamp..... 456
Benzine Locomotives 623
Benzine Locomotives, Belgian Haulage Tests 686
Benzole, Locomotive, Accident With..... 288
Bering River Coal Field, Prospecting..... 347
Bering River Coal Fields, Conditions Affecting Mining 481
Bering River Coal Unfavorable, Tests of... 395
Bevan, John F., Promotion..... 766
Berwind-White Coal Mining Co., Portable Substation 454
Big Business and Mining..... 694
Bines, W. H., Efficiency in Mine Haulage.. 171
Bin, Steel Slack 518
Birds in Coal Mines..... 122
Bit Machine, The Morris..... 713
Bituminous Coal Industry and the Sherman Law 569
Bituminous First-Aid Movement..... 222
Bituminous Mining Law, 1911..... 546
Black Diamond Concrete Tipple..... 475
Black Diamond, "Near-Doomed Cities"..... 1
Blackiston, G. P., Advantages of Steel Mine Cars 172
Blame Where it Belongs, Put the..... 265
Blasting With Two Exploders..... 693
Blight Killed Chestnut..... 86
Blowers, Coppus Turbo..... 586
Branch Track, Portable..... 611
Breaker at Whitwick Colliery, Coal..... 402
Breakers, Dustless 29
Breaker, Short Mountain..... 267
Breaking Colliery Rules..... 719
Breast Turret Coal Cutters..... 259
Breyhan, Bergassessor, German Rescue Organization 284, 355
Brick, Fusion of Fire and Silica..... 59
Brick Tipple, A..... 527
Bridges or Brains?..... 666
Briggs, Alfred, Wire-Rope Haulage..... 173
Briggs, Henry, Testing for Firedamp With Wire Loop 344
Briquet for Saving Fuel Waste..... 417
Briquets in France..... 27, 354
Briquets in Germany, Lignite..... 51
Briquets in Holland, Manufacture of..... 682
Briquets of Coal and Naphthalene..... 262
Briquets, Use of Naphthalene in Coal..... 564
Bristol's Pneumatic Type Recording Tachometer 582
British Coal-Dust Precautions..... 472
British Coal Mines Act, 1911..... 529
British Columbia Notes..... 56
British Mines, State Interference..... 738
Brookside Mine Disaster..... 101
Brown, George, Hoisting Engineer..... 643
Brush Shifting Polyphase Motor..... 584
Buchanan, Gordon, Preparation of Coal..... 51
Bulldog Die Stock 327
Bulletin Board 594
"Bumps" Their Cause and Effect..... 551
Bureau of Mines Rescue Cars, Itinerary... 206
Bureau of Mines, The..... 331

Page

Bureau of Mines, Unfair Criticism of..... 589
Burning Low-Grade Anthracite..... 567
Burroughs, Wilbur Greeley, A Brick Tipple, 527—Black Diamond Concrete Tipple, 475—Illsylvania Mine No. 23, 421—Ohio Mine Rescue Car, 411—Origin of Coal, 271, 351—Panel System in Ohio, 562—Longwall Mining in Ohio..... 729
Business and Mining, Big..... 694
Business Regulation, As to..... 331
Butler, M. C., The Employer's Duty..... 615
By-product Ovens, Coal Saved by..... 181

CABLE, LARGE ARMORED..... 504
Cage at St. Michael, Four-Decked..... 5
Cage, Automatic Self-Dumping..... 646
California Oil 554
California Oil Fields 550
California State Mineralogist..... 752
Campbell, J. R., Basic Coke, 409—Neutral Coke—Diehl-Faber Process 691
Canada, Coal Fields of Western..... 11
Canada, Duty on Rescue Appliances..... 55
Canadian Coal Production, 1910..... 244
Canadian Mining Institute Meeting..... 408
Canadian Mining Institute Office..... 478
Canary Birds in Mines..... 122
Capacity of Car.....513, 573
Capacity of Pipes and Cylinders..... 501
Cape Breton Coal Field, Opening Nova Scotia Coal Mines..... 595
Cape Breton, Coal Mines Under the Sea..... 17
Caps, Placing in Cartridge..... 622
Carbide, Be Careful of..... 690
Carbide Lamp, Defense of..... 179
Carbon Monoxide a Supporter of Combustion, Is 38
Carbon Monoxide, Testing for..... 14
Car, Capacity of.....513, 573
Care and Lubrication of Air Compressors... 164
Car Loader, The Manierre 261
Carrying the Meridian Down a Shaft..... 543
Carrying the Meridian Underground..... 95
Cave, Cost of Mine..... 751
Car, Underground Rubbish..... 180
Cave Problem, Anthracite Mine..... 264
Caves, Common Sense Regarding Surface Settlements 459
Cement Gun and Gunite..... 617
Cementation Process for Sinking Shaft..... 234
Centimeter-Gram-Second System 76
Central Station Possibilities, Cooperative.. 502
Chance, E. M., Ability of Acetylene Flame to Show Dangerous Gases, 239—Experiments With Acetylene Lamps..... 50
Change in Alberta Mining Law..... 360
Channing, J. Parke..... 654
Charlton, W. H., Insurance on Mine Property 549
Chestnut, Blight Killed..... 86
Chicago Pneumatic Tool Co., New Two-Stage Air Compressors..... 392
Chute Stop, Automatic..... 474
Circular Pillars 396
Clinkering of Mixed Coals..... 368
Coal Analyses, Value of..... 242
Coal and Coke Productions, 1912..... 361
Coal and Coke Section of A. I. M. E..... 570
Coal at Panama Pacific Exposition..... 313
Coal Breaker at Whitwick Colliery..... 402
Coal-Coal 198
Coal Competition 2
Coal Creek, B. C., "Bumps" Their Cause and Effect 551
Coal Creek Mine 18
Coal Dust, Natural History of..... 689
Coal-Dust Precautions, American..... 739
Coal-Dust Precautions, Belgian..... 599
Coal-Dust Precautions, British..... 472
Coal-Dust Precautions, French..... 403
Coal-Dust Precautions, German..... 533
Coal Exports in United States, 1912..... 306
Coal Field History 598
Coal Field Investigated, New..... 274
Coal Fields of Jasper Park, Alta..... 309

Page

Coal Fields of Western Canada..... 11
Coalinga Oil Problems..... 462
Coal Land? What is..... 224
Coal Loading Methods..... 745
Coal, Loss of Heat Units With Time..... 424
Coal Mine Dividends..... 1
Coal Mines Under the Sea..... 17
Coal Mining Comparatively Safe..... 572
Coal Mining, Cost of..... 281
Coal Mining Institute of America..... 594
Coal Mining Institute of America, June, 1913, Meeting 26
Coal Mining Institute of America, June, 1914, Meeting 764
Coal Mining Institute of America, December, 1913 .....274, 372
Coal Mining Machines..... 77
Coal, Origin of.....271, 351
Coal, Oxidation of 316
Coal, Preparation of..... 51
Coal Preparation on the Marcus Screen..... 775
Coal Production in Kansas in 1912..... 244
Coal Production Pennsylvania, 1912..... 245
Coal Production Per Man, Various States.. 634
Coal Saved by By-Product Ovens..... 181
Coal, Selling Price of..... 412
Coal, to Market, Pumping..... 381
Coal, Weathering of Pittsburg 744
Coals, Clinkering of Mixed..... 368
Coal Trade, 1914..... 329
Coal Used for Coke Making, 1912..... 262
Coke 653
Coke, Analysis of..... 529
Coke, Basic 469, 725
Coke, First Connellsville Ovens..... 350
Coke Manufacture, Pro's and Con's..... 312
Coke Making, Coal Used for..... 262
Coke, Neutral—Diehl-Faber Process..... 691
Coke Oven Gas for Power Purposes..... 407
Coke Oven, Plant, Rectangular..... 683
Coke Ovens, Gas Exhauster for..... 288
Coke Production, Pennsylvania, 1912..... 407
Coke Production, United States, 1912..... 52
Coke Samples, Selection of..... 363
Coking, Waste in 74
Colorado Coal Mines, Lighting of..... 66
Colorado, Trouble in..... 703
Colter, R. A., Selling Price of Coal..... 412
Columbia School of Mines..... 618
Columbia School of Mines, 50th Anniversary 561
Column-Pipe Cleaner, Porcupine..... 337
Combination Tool for Miners..... 648
Common Sense Regarding Surface Settlements 459
Combustion in High Altitudes..... 366
Compensation Act, West Virginia's..... 228
Competition, Coal 2
Complete Mine Maps 91
Compound Interest by Logarithms.....179, 312
Compressed-Air Mine Haulage..... 142
Compressed-Air Plant, Electrically Driven 94
Compressor, New Two-Stage Air..... 392
Compressors, Oil in Air Receivers..... 768
Compressors, Portable Air 260
Conciliation Board, Anthracite..... 523
Concrete Tipple, Black Diamond..... 475
Conditions Affecting Mining in Bering River and Matanuska Coal Fields..... 481
Connecting Steam Turbines for Operating on Exhaust Steam..... 60
Connell Colliery Hospital..... 201
Connellsville Ovens, First..... 350
Conradson, Dr. T. H., Specifications for Lubricating Oil 314
Conservation Begins at Home..... 495
Conservation Exposition, National..... 16
Consolidation's No. 21 Tipple, Fire at..... 494
Continental Mine, Rescue of Entombed Miner 233
Conveying Sand by Compressed Air....108, 312
Cooperation in Mining Engineering..... 717
Cooperative Central Station Possibilities... 502
Coppus Turbo Blowers..... 586
Correction, Austrian Trial Gallery..... 617
Correction, Eureka No. 36..... 131

Page

Correction, Frank, Alta..... 311
Correspondence, See "Letter Box".....
Cost of Coal Mining..... 281
Cost of Cylinder Oils..... 575
Cost of Mine Cars 751
Cost of Mining as Related to Output..... 158
Cost of Mining as Related to Output, Correction 366
Cost of Power, Calgary..... 56
Coulston, P. Barrett, Should Exhaust Steam Be Wasted? 41
Cover Picture, November..... 198
Covers: August, 1913, Shaft Bottom, St. Michael—September, A California Coal Mine—October, Underground Dentist—November, Women's First-Aid Team—December, Welch Advertisement—January, 1914, Furnace Run Tipple; February, Colliery Engineer Advertisement—March, Fairmont Mining Machinery Co. Advertisement—April, Driving Heading in Anthracite—May, Compound "Hay Burning" Mine Locomotive—June, Advertisement, National Tube Co.—July, Kingston Coal Co. Play Grounds.
Crane, W. R., Conditions Affecting Mining in Bering River and Matanuska Coal Fields, 481—Prospecting Bering River Coal Field 347
Cranston, M., Qualifications for Certificate in Alberta 700
Crawford, Wm. B., Shaft Sinking in Wet Ground 108
Crust of the Earth 732
Culm, Pumping 381
Cylinder Lubricants 777

DALLAS SHAFT 30
Darton, N. H., Gas in Coal..... 409
Davidson, Jas. L., Moistening Coal Dust... 559
Davis Act 329
Davis & Sons (Derby) Ltd., John, Signaling in Gassy Mines 175
Davis Instrument Mfg. Co., New Anemometer, 327—Pocket Mining Hygrometer..... 391
Davis, W. W., Economical Lubrication..... 478
Dawson, N. Mex., Mine Disaster..... 365
Dean, Samuel, Ravenswood Explosion..... 607
Deemer, F. J., Large Armored Cable..... 504
Defense of the Carbide Lamp..... 179
DeKoven Movable River Tipple..... 736
De Laval Steam Turbine Co., Operating Turbines on Exhaust Steam..... 61
D., L. & W. Coal Mining Department..... 439
Delaware, Lackawanna & Western Co., First-Aid Meet, 1913..... 219
Deming Co., The, A New Mine Pump..... 648
Depreciation 558
Depth and Thickness of Anthracite Seams 481
Destruction in Mexico..... 636
Detonators, Placing in Cartridge..... 622
Dewatering a Flooded Mine, Effect on Roof of 381, 441
Dickinson, W., Location of Regulator..... 39
Diehl-Faber Process, Neutral Coke..... 691
Distances, Not Spring Poetry..... 590
Dividends of Metal and Coal Mines..... 1
Doors Being Left Open, To Prevent Mine.. 431
Double Explosion of Dynamite..... 54
Draeger Oxygen Apparatus Co., Self-Rescuing Apparatus 585
Drills, Air Hammer vs. Rotary..... 554
Dump Car Wanted 38
Dunaime, Pol., Air Hammer vs. Rotary Drills, 554—French Coal-Dust Precautions 403
Duncan, Robert Kennedy, Science and Industry Allied 630
Dust, Anthracite 588, 700
Dust, Explosibility of Anthracite..... 653
Dust Explosions, Prevention of Coal..... 10
Dust Explosive? Is Anthracite..... 109
Dust in Collieries, Production of Stone..... 90
Dustless Breakers 29
Dust, Moistening Coal..... 559
Dust, Natural History of Coal..... 689

Page

Dust Precautions, American Coal..... 739
Dust Precautions, Belgian Coal..... 599
Dust Precautions, British Coal..... 472
Dust Precautions, German Coal..... 533
Dust Precautions, French Coal..... 403
Dust Shelves 10
Dusty Coal Mines, Stone Dusting in..... 574
Dynamite Anyhow? What is..... 181
Dynamite, Thawing 238

EARTHQUAKE, NO EXPLOSION..... 459
Earthquakes and Mine Explosions..... 460
Earthquakes (Gas in Coal)..... 499
Earthquakes, Influence of 513
East Brookside Disaster 66
East Brookside Mine Disaster..... 101
Eccles Mine Explosion 733
Eccles, W. Va., Disaster..... 652
Eckley First-Aid Team 192
Economical Lubrication 478
Editorial .....
1, 65, 131, 197, 263, 329, 395, 459, 523, 587, 651, 717
Educated Fingers 436
Education for Miners, A False Doctrine..... 330
Edwards, J. C., Machine Mining in Room Pillars 591
Ede, J. C..... 654
Effect on Roof of Dewatering a Flooded Mine 381, 441
Efficiencies in Mine Engineering..... 753
Efficiency Expert 686
Efficiency in Mine Haulage..... 171
Efficiency Thoughts in Coal Mining..... 749
Efficiency Valuation of Fuels..... 23
Electrically Driven Compressed Air Plant.. 94
Electricity in Mines....47, 116, 182, 247, 309, 387
Electricity in Mines, Safeguarding..... 619
Electric Locomotive, Field Test of..... 157
Electric Locomotive, Storage Battery..... 146
Electric Mine Gas Detectors..... 604
Electric Mine Haulage..... 301, 338
Electric Mine Lamp..... 558
Electric Mine Lamp, Approved..... 63
Electric Safety Lamps for the Powder Men 520
Electro-Pneumatic Air Compression..... 681
Elmer, H. N., "Proto" Fleuss-Davis Apparatus 63
Elwood, W. F., Efficiency Valuation of Fuels 23
Emergency Hospital 382
Employer's Duty, The 615
Employes' Magazine 117, 381
Engel, Geo. W., Anthracite Mine Engineering 753
Engineering, Anthracite Mine..... 753
England, Strange Accident 765
English Explosions in Mines Committee, Report of 92
Eureka 716
Eureka Timber Hook 126
Evans, A. W., Mining Plant of Petros Coal Co. 151
Evans, George Watkin, The Issaquah Coal Mine, 663—Working an Inclined Coal Bed 18
Examinations:
Alabama Fire Boss, Birmingham, January, 1913 123
British Columbia, First-Class Candidates, May, 1913, 383—First-Class and Second-Class Certificates 576
Illinois, Mine Manager, Mine Examiner and Hoisting Engineer, Springfield, January and April, 1913..... 189, 250
Illinois, Mine Manager, Mine Examiner and Hoisting Engineer, Springfield, September and December, 1913..... 515, 576
Nova Scotia, Underground Manager, 1913 448
Pennsylvania, Mine Foreman and Assistant Mine Foreman, Carbondale, June, 1913, 317—Mine Foremen and Assistant Mine Foremen, Pottsville, May 25, 1914 771
Pennsylvania, Mine Inspector, Pottsville, May, 1913 33
Wyoming Mine Foreman, Sheridan, 1914 ..... 637, 707

Page

Examinations, Reference Books at..... 2
Explosibility of Anthracite Dust..... 653
Explosions, Acton, Alabama 440
Explosion at the Oberhausen Colliery, Germany 603
Explosion, Auckland Park Colliery..... 416
Explosion, Brookside Mine Disaster..... 101
Explosion, Eccles Mine..... 733
Explosion, Dawson, N. Mex..... 365
Explosion, East Brookside Disaster..... 66
Explosion from Poor Detonator..... 765
Explosion Not Caused by Acetylene..... 702
Explosion of Dynamite, Double..... 54
Explosion Proof Motors..... 96
Explosion, Ravenswood 607
Explosions, Analyses of Mine..... 435
Explosions, Earthquakes and Mine..... 460
Explosions in Mines Committee, English.. 92
Explosions, Prevention of Coal Dust..... 10
Explosives 170
Explosives, Advances in Permissible..... 111
Explosives, Nature of Permissible..... 491
Explosives Used in West Virginia..... 736

FACTS CONCERNING THE MINING INDUSTRY 532
Fairmont Endless Cable Car Haul..... 176
False Doctrine, A 330
Farrell, J. H., Combination Tool for Miners 648
Federal Coal and Coke Co., Welfare Work at Grant Town, W. Va..... 724
Feeding Graphite to Boilers..... 393
Feedwater Difficulties 714
Fiber or Paper Air Pipe..... 442
Field Test of Electric Locomotive..... 157
Filling as Roof Support, Hydraulic..... 225
Filling, Relation of Subsidence to Packing 87
Fire and Ventilation..... 700
Fire at Consolidation's No. 21 Tipple..... 494
Firedamp with Wire Loop, Testing for..... 344
Fire, Handling a Mine..... 749
Fire Protection of Mines..... 28
Fire, Mine 16
First-Aid Contest, Woodward, August, 1914 760
First-Aid Contests 131
First-Aid Meet, Saline County..... 672
First Aid, Miners' Field Day, Knoxville.. 80
First-Aid Movement, Bituminous..... 232
First Aid, Schaefer Method of Resuscitation 53
First-Aid Team Meets, Kentucky..... 22
First-Aid to the Injured, Contests, 1913..... 207
First-Aid Judging 199
First Connellsville Ovens 350
Fleuss-Davis Apparatus, The "Proto"..... 63
Flooded Coal Mine in Illinois..... 570
Florida, Highest Point..... 283
Flory Mfg. Co., After the Fire..... 261
Flushing, Hydraulic Filling as Roof Support 225
Flushing in French Collieries..... 289
Force vs. the Constitution 718
Ford, Leo Dorey, Rheolaveur Coal Washer 555
Forestry, Income Tax and..... 462
Foster, Rufus J., Uniformity in Inspectors' Reports 565
Four-Cylinder Triple Expansion Engine.... 712
Four-Decked Cage at St. Michael..... 5
Frank, Alta, Location of..... 311
Franklin Institute of Pennsylvania..... 590
Fraser, Norman, Change in Alberta Mining Law 360
Freeman, W. E., Safeguarding Electricity in Mines 619
French Coal-Dust Precautions..... 403
Frick Coke Co., First-Aid Contest, 1913..... 210
Frick Coke Co., Moving Pictures..... 97
Frogless Switch 154
Fuels, Efficiency Valuation of..... 23
Furnace Run Mines 333
Fusion of Fire and Silica Bricks..... 59

GALLOWAY, C. F. J., BRITISH COAL-DUST PRECAUTIONS 472
Gardens at Weyanoke, Prize 359

Page

Gary, Steel Competition Mines at 463
Gary, W. Va., Moving Pictures in Accident Prevention 495
Gas Detectors, Electric Mine..... 604
Gas Engines in a New Field, Producer..... 176
Gases and Ventilation 635
Gas Exhauster for Coke Ovens..... 288
Gas for Power Purposes, Coke Oven..... 4 7
Gas in Coal 499
Gasoline Mine Locomotives..... 153
Gasoline Motors in Coal Mines..... 164
Gasoline-Operated Rock Drill..... 519
Gasoline Pump 715
Gasoline Rock Drill, Rice..... 260
Gas, Ventilating Mines and Removing..... 81
Gate Controlling Device, Shaft..... 299
Gates for Shafts, Safety..... 162
Gathering Locomotive for Low Coal..... 715
General Electric Co. Brush-Shifting Polyphase Motor 584
Gerber, Dwight, Mine Humidification..... 229
German Coal-Dust Precautions..... 533
German Mine Explosions 435
German Rescue Organization..... 284, 355
Gibson, George H., Operating Turbines on Exhaust Steam 60
Giles, A. E., Shaft Gate Controlling Device 299
Girard Estate 60
Goodman Coal Cutters 77
Goulds Portable Mine Pumps..... 715
Goulds Mfg. Co., Rotary Power Pump..... 128
Goulds Storage Battery Co., Storage Battery Locomotive 646
Grahn, Bergassessor, Use of Napthalene in Coal Briquets 564
Grant Town, W. Va., Welfare Work at.... 724
Graphite Lubrication 193
Graphite to Boilers, Feeding..... 392
Greatbatch, G. H., Training of Rescue Brigades 678
Greene, F. C., Correction..... 90
Griffith, Wm., Leasing of Mineral Lands, 167—The Personal Equation..... 612
Griffiths, W. T., Kentucky System of Land Surveys 675
Gunite, The Cement Gun and..... 617
Gunsolus, F. H., What is Dynamite Anyhow? 181

HADESTY, GEORGE B., PROMOTION.. 766
Halberstadt, Baird, Taxation of Anthracite 70 Years Ago..... 306
Hall, Clarence, Nature of Permissible Explosives 491
Hammer vs. Piston Rock Drills..... 581
Handling a Mine Fire..... 749
Hanley, G. S., Information Wanted..... 635
Harris-Stevens Co., A New Mine Car Truck 583
Harter, H. W., Electric Safety Lamps for the Powder Men 520
Hauck Mfg. Co., Kerosene Blow Pipe..... 456
Haulage at Sayreton, Ala., Slope..... 155
Haulage, by the Manufacturers..... 171
Haulage Clips, Notes on..... 425
Haulage, Compressed Air Mine..... 142
Haulage, Electric Mine..... 301, 338
Haulage in Mines, Animal..... 139
Haulage, Practical Mule..... 166
Haulage Problem..... 443, 514, 635, 701
Haulage Systems, Rope..... 174
Haulage Tests, Belgian..... 686
Haulage, Wire Rope..... 173
Haworth, Erasmus, Efficiency Thoughts in Coal Mining 749
Hayton Pump Co., Self-Contained Portable Pump 715
Hazard Mfg. Co., Large Armored Cable.... 504
Hazardous Mines 330
Heroism, Real 382
Herstine, A. W., Welfare Work at Grant Town 724
Herzler & Henninger Machine Works, Automatic Self-Dumping Cage..... 646
Hinkel Automatic Safety Stop..... 714

Page

Hirsch Electric Mine Lamp Co., Approved Electric Mine Lamp..... 63
Hirsch Electric Mine Lamp, Improved..... 454
Hisylvania Mine No. 23..... 421
Hockensmith, W. D., Mine Car Construction 175
Hogan on Taxation of Anthracite..... 15
Hoist, New Room..... 454
Hookworm in the Pocahontas Coal Field..... 767
Hornblower, J. B. L., Mine Accounting..... 362
Hospital, An Emergency..... 382
Hospital, Connell Colliery..... 201
Hospital, Kingston Coal Co..... 501
Houses for Miners, New..... 364
How to Handle a Dry or Dusty Mine..... 99
Huber, Charles F., Biography..... 691
Humidification, Mine 229
Hyatt Roller Bearings Applied to Mine Cars 173
Hydraulic Filling as Roof Support..... 225
Hydraulic Stowing in French Collieries.... 289
Hygrometer, New Recording..... 391
Hygrometer, Pocket Mining..... 391

IDAHO COAL BEDS 711
Illinois Coal Statistics, 1913..... 224
Illinois, Flooded Coal Mine in..... 570
Illinois, Large Coal Output..... 575
Illinois Mine Fire Fighting and Rescue Station Commission Rules..... 105
Illinois Mine Inspectors 654
Illinois Mine Rescue Commission, Saline County First-Aid Meet 692
Illinois Mining Institute..... 617, 705
Illinois Mining Institute, November, 1913.. 373
Important and Deserved Promotions..... 766
Improved Automatic Water Gauge..... 127
Improved Measuring Tapes 521
Income Tax and Forestry..... 462
Indiana, Resolutions of the United Mine Workers 458
Induction Motors, Operating 609
Induction Motors, Selection of..... 544
Industrial Instrument Co., New Recording Hygrometer 391
Industrial Welfare and Efficiency Contest 134
Influence of Earthquakes 513
Information Wanted 441, 635
Ingersoll-Rand Co. Hammer vs. Piston Rock Drills, 581—Rock Drill Operated by Gasoline Engine, 519—Oil Driven Air Compressor 778
Inspectors' Reports, Uniformity in..... 565
Inspectors' Reports, Uniformity in State Mine 524
Insurance on Mine Property..... 549
Interest by Logarithms, Compound..... 179, 312
Interferometer, The 509
International Congress of Social Insurance 505
International Engineering Congress..... 453
International Engineering Congress, 1913... 150
International Engineering Congress, 1915.. 666
International Study of Coal-Dust Problem. 688
Is Anthracite Dust Explosive?..... 109
Issaquah Coal Mine..... 663
Itinerary of Bureau of Mines Rescue Cars 206

JACKMAN, W. J., INFORMATION WANTED 441
Jasper Park, Alberta, Coal Fields of..... 399
Jeffrey-Drennen, Adjustable Turret Cutter 325
Jeffrey Mfg. Co., Breast Turret Coal Cutters, 259—New Wrinkle in Cutting Coal... 192
Jeffrey Wagon Loader 779
Jenkins, Mining in Eastern Kentucky..... 530
Johns-Manville Co., Fiber or Paper Air Pipes 442
Johnson, A. H. W..... 590
Johnson, F. S., Pro's and Con's on Coke Manufacture 312
Jones, B. C., Cost of Mining as Related to Output 158
Jones, J. E., Eureka Timber Hook..... 126
Judd, W. N., Rectangular Coke Oven Plant 683

Page

KAERCHER, EDWARD E., PROMOTION 766
Kansas, Strip-Pit Mining in..... 232
Keighley, Fred C., Selection of Coke Samples 363
Kentucky Coal Mines, Western..... 414
Kentucky First-Aid Team Meets..... 22
Kentucky, Mining in Eastern..... 530
Kentucky Mining Institute and First-Aid Contest, May, 1914..... 606
Kentucky Mining Institute, June, 1914, Meeting 762
Kentucky Mining Institute, December, 1913 ..... 306, 373
Kentucky State University, Successful Miners' Course 698
Kentucky System of Land Surveys..... 675
Keep on Rowing 588
Kerosene Blowpipe 456
Kewanee Air-Pump Union..... 393
King, A. J., Gasoline Motors in Coal Mines 164
King, S. B., Conveying Sand by Compressed Air 312
Kingston Coal Co.'s Hospital..... 501
Kingston Coal Co., Welfare Work..... 497
Knox, Geo., Hydraulic Filling as Roof Support, 225—Relation of Subsidence to Packing 87
Knoxville First-Aid Meet, 1913..... 212
Kober, Jos., Portable Branch Track..... 611

LA BELLE SHAFT MINE, LONGWALL MINING 729
Lakes, Arthur, Coal Fields of Western Canada 11
Lake Superior Mining Institute..... 15
Lamp, Approved Electric Mine..... 63
Lamps, Electric Mine 588
Lamps for the Powder Men, Electric Safety 520
Land and the Common Law..... 442
Large Armored Cable 504
Large Electric Hoist..... 456
Largest Mine Locomotive Ever Built..... 325
Law, Bituminous Coal Industry and the Sherman 569
Law, Change in Alberta Mining..... 360
Law in Missouri, New Mining..... 3
Law, 1913, Bituminous Mining..... 546
Laws, Ohio's Foolish Mine 524
Leasing of Mineral Lands..... 167
Lecture on Technical Reports..... 682
Lehigh Valley Coal Loading Methods..... 748
Lehigh & Wilkes-Barre Coal Co..... 691
Lehigh & Wilkes-Barre Coal Co., First-Aid Meet, 1913 218
Lehigh Coal and Navigation Co., Field Day, 1913, 222—Panther Valley Institute..... 286
Lehigh Valley Coal Co., Employes' Magazine, 107—First-Aid Meet, 1913, 213—Large Armored Cable, 504—Packer No. 5, Mine Fire, 553—Rescue of Entombed Miner, 233—Schools, Closing Exercises..... 25
Letter Box
Acetylene Lamp Difficulties, 109—Acetylene Lamps, 180—Anthracite Dust, 700—Capacity of Car, 513, 573—Carbon Monoxide Not a Supporter of Combustion, 38—Compound Interest by Logarithms, 179, 312—Conveying Sand by Compressed Air, 108, 312—Defense of the Carbide Lamp, 179—Dump Car Wanted, 38—Effect on Roof of Dewatering a Flooded Mine, 381, 441—Emergency Hospital, 382—Fiber or Paper Air Pipes, 442—Gases and Ventilation, 635—Haulage Problem, 443, 514, 635, 701—Influence of Earthquakes, 513—Information Wanted, 441, 635—Is Anthracite Dust Explosive? 109—Is Carbon Monoxide a Supporter of Combustion? 38—Land and the Common Law, 442—Method of Mining Wanted, 635—Miner's Inch, 700—Mine Safety Association, 382—Nova Scotia Examinations, 108—Oil in Air Receivers, 678—Oklahoma Undercutting Law Repealed, 180—Open Lights in Well-Ventilated Mines, 700—Pillar Drawing, 313, 442—Prevention of Accidents, 573—Pro's and Con's on Coke Manufacture, 312—Pumping, 513—Pumping Coal to Market, 381—Qualifications for Certificate in Alberta, 635, 700—Rescue Work Instruction, 573—Rope Lubrication, 441—Single-Motor vs. Two-Motor Types of Mine Locomotive, 441—Shaft Sinking in Wet Ground, 108—Some Reflections, 768—Stone Dusting in Dusty Coal Mines, 574—Tennessee Mining Law, 312—Test of Safety Lamps, 108—"The Wisest Man," 381—Underground Rubbish Car, 180—Ventilation and Fire, 700—What is Dynamite Anyhow? 181
Lloyd, Strauss A., Land the Common Law 443
Lighting of Colorado Coal Mines..... 66
Lignite Briquets in Germany 51
Lignite Mining at Hoyt, Texas..... 93
Link-Belt Co., Making the Truck Pay..... 646
Litchfield Foundry and Machine Co., Shaft Stairway 714
Loader, Jeffrey Wagon 779
Loading Methods, Coal 745
Location of Regulator 38
Locomotive, Field Test of Electric..... 157
Locomotive for Low Coal, Gathering..... 715
Locomotive Record at Scalp Level..... 521
Locomotive, Benzine 623
Locomotives, Gasoline Mine 153
Locomotive, Storage Battery..... 146
Locomotives, Storage Battery..... 646
Locust Mountain Coal Co., Weston Colliery 726
Lodge, Capt. Wm. M..... 441
Lof, Eric A., Electric Mine Haulage....301, 338
Longwall Method of Mining..... 486
Longwall Mining in Ohio..... 729
Lord, N. W., Value of Coal Analyses..... 242
Lovatt, A. L., Notes on Haulage Clips..... 425
Lowe, W. Va., Mining at..... 433
Lubricating System 393
Lubricating Tests, Practical..... 687
Lubrication, Economical 478
Lubrication of Air Compressors, Care and.. 104
Lubrication, Rope 441
Lufkin Rule Co., Improved Measuring Tape 521
Lumbering in National Forests..... 381
Lunkenheimer Company, Improved Automatic Water Gauge..... 127
Luxton, W. H., Acetylene Lamps, 180—Pillar Drawing 442
Lyman, G. E., Dump Car Wanted..... 38
Lynch, Pat J., Location of Regulator..... 38

MACHINE MINING ADVANTAGES OF Machine Mining in Room Pillars..... 435 591
Madison Coal Corporation Exhibition..... 275
Magyar Miners in West Virginia..... 601
Mahin, Frank W., Manufacture of Briquets in Holland 682
Making the Truck Pay 646
Maltby Colliery, Large Armored Cable..... 504
Manley, B. P., Somerset Mine..... 667
Manierre Car Loader 261
Manufacture of Briquets in Holland..... 682
Maple Hill Compressed-Air Haulage..... 142
Maps, Complete Mine..... 91
Marcus Screen, Coal Preparation on..... 775
Marsh, D. W., Safety Powder Can..... 455
Martin, Peter, Information Wanted..... 635
Marvel, Alabama, Alabama Coal Operators' Association 69
Maryland Coal Co., St. Michael..... 5
Matanuska Coal Fields, Conditions Affecting Mining 481
Mazey, Wm. John, Underground Rubbish Car 180
McDonnell, Dr. M. E., Purchase of Lubricating Oil 357
McGregor, Charles P., Prevention of Accidents 573
McKesson-Rice Screeniess Sizer..... 127
McNatt, J. Q., Compound Interest by Logarithms, 179, 312—Frogless Switch..... 154

Page

Mechanics of Mining....43, 114, 184, 246, 307, 387
Menner, H. M., Acetylene Lamps in Coal Mines, Experiments 49
Meridian Down a Shaft, Carrying the..... 543
Meridian Underground, Carrying..... 95
Meridiograph, The 677
Mesta Machine Co. 522
Metal Mine Dividends..... 1
Meter for Mines, Pressure and Velocity.... 300
Method of Mining Wanted..... 635
Method of Tamping for Greater Safety in Blasting 321
Methods of Utilizing Small Coal and Slack 658
Mexican Coal Mine, Destruction of..... 132
Mexico, Destruction in 636
Michigan Notes 55
Miller, Wilbert A., Coal Mining Machines 77
Miller, Willett G., Complimentary Dinner.. 377
Mine Accidents in Great Britain, 1912..... 238
Mine Accounting 362
Mine Car Construction 175
Mine Car Truck, A New..... 583
Mine Caves "Near-Doomed Cities"..... 1
Mine Door at Seneca, Automatic..... 360
Mine Fires 16
Mine, How to Handle a Dry or Dusty..... 99
Mine Humidification 229
Mine in National Muscum, Model Coal..... 621
Mine Inspectors' Institute 601
Mine Inspectors' Institute of America, June, 1914, Meeting 764
Mine Inspectors, Same Old Story..... 198
Mine Officials 197
Mineral Classification 752
Mineral Man, The 632
Miner Entombed for Eight Days..... 233
Mine Rescue Crews in Kansas..... 220
Miners' Course, A Successful..... 698
Miners' Field Day, Knoxville, Tenn..... 80
Miner's Inch 700
Miners' Phthisis 634
Miners' Vocational Schools..... 235
Miners Working Days Per Year..... 659
Mine Safety Association 382
Mines Under the Sea, Coal..... 17
Mines, Visiting Coal 533
Mine Tracks 152
Mine Ventilation....45, 112, 186, 248, 308, 390, 452
Mining as Related to Output, Cost of..... 158
Mining at Lowe, W. Va..... 433
Mining Comparatively Safe, Coal..... 572
Mining, Cost of Coal..... 281
Mining Education 636
Mining Engineers' Association 732
Mining Exhibit at the Panama Pacific Exposition 424, 462
Mining Industry, Facts Concerning the.... 532
Mining in Eastern Kentucky..... 530
Mining in Room Pillars, Machine..... 591
Mining Institute Meetings.....372, 760
Mining, Longwall Method of..... 486
Mining Machinery at Exposition..... 65
Mining Machines, Coal..... 77
Mining Malaise 66
Mining, Mechanics of...43, 114, 184, 246, 307, 387
Mining, Panel System in Ohio..... 562
Mining Plant of Petros Coal Co..... 151
Missouri, New Mining Law in..... 3
Mitchell, Guy E., Waste in Coking..... 74
Mitchell, T. J., Steel Slack Bin..... 518
Model Coal Mine in National Museum..... 621
Moderwell, Chas. M., Bituminous Coal Industry and the Sherman Law..... 569
Moehrle, T., Methods of Utilizing Small Coal and Slack 658
Moistening Coal Dust 559
Moistening, Mine Humidification..... 229
Montana, Coal Fields, Western..... 721
Montana, New Coal Field..... 274
Moorshead, A. J., Advantages of Machine Mining, 435—Madison Coal Corporation Exhibition 275
Morgan-Gardner Electric Co., New Coal Cutter 585

Page

Morgan, W. L. 590
Morris Bit Machine..... 713
Morris, F. G., Slope Haulage at Sayreton, Ala. 155
Moses, Thomas, Safety First..... 236
Motor, Brush-Shifting Polyphase..... 584
Motors, Explosion Proof..... 96
Motors, Selection of Induction..... 544
"Mountains of High-Grade Coal"..... 589
Mount Pleasant Bath House 354
Movable River Tipple 736
Moving Pictures as Aid to Mine Accident Prevention 97
Moving Pictures for Accident Prevention.. 495
Moving Pictures, to Illustrate Accidents... 65
Muckle Cup Contest, Red Cross, 1913..... 211
Mule Haulage in Mines..... 139
Mule Haulage, Practical..... 166
Mule, Passing of the Mine..... 198
Mules, Cost of..... 702
Mules, Price of..... 192

NAOMI MINES, EMERGENCY HOSPITAL 382
Naphthalene, Briquets of Coal and..... 262
Naphthalene in Coal Briquets, Use of..... 564
National Conservation Congress.....192, 353
National Conservation Exposition..... 16
National Graphite Lubricator Co., Graphite Lubrication 193
National Tube Co., Kewanee Air Pump Union 393
Natural History of Coal Dust..... 689
Nature of Permissible Explosives..... 491
Nelson-Erwood Swing-Gate Valve..... 644
Nelson Non-Return Valve..... 713
Neutral Coke—Diehl-Faber Process..... 691
Nevada, Highest Point..... 270
New Belgian Coal Field..... 188
New Coal Cutter 585
New Coal Field Investigated..... 274
New Executives for Prominent Anthracite Companies 690
New Houses for Miners..... 364
New Journal 408
New Method of Handling Rock..... 765
New Mine Safety Sign 236
New Mine Section Insulator..... 126
New Mexico School of Mines..... 54
New Mining Law in Missouri..... 3
New Mining Machinery..... 60, 126, 193, 259, 325, 391, 454, 519, 581, 644, 712, 775
New Owner of the Temple Iron Co.'s Collieries 689
New Recording Hygrometer 391
New Rock Plane 686
New Room Hoist..... 454
Newton, Leonard V., Field Test of Electric Locomotive 157
New Two-Stage Air Compressor..... 392
New Wrinkle in Cutting Coal..... 192
1911 Bituminous Mine Law..... 546
Non-Hazardous Mines 330
Norris, R. V., Taxation of Coal Lands..... 437
Notable Colliery Record..... 311
Notes on Haulage Clips..... 425
Not Spring Poetry 590
Notes on Mines and Mining..... 55, 105, 244, 377, 446, 575, 630, 706
Nova Scotia Coal Mines, Opening..... 595
Nova Scotia, Coal Mines Under the Sea.... 17
Nova Scotia, Coal Output First Quarter, 1914 630
Nova Scotia Examinations 108
Nova Scotia Mines 377

OBERHAUSEN COLLIERY, EXPLOSION AT 693
Odell, C. M., Opening Nova Scotia Coal Mines 595
Ohio Brass Co., Mine Section Insulator..... 126
Ohio Grease Co., Cylinder Lubricants..... 777
Ohio Grease Co., Lubricating System..... 393
Ohio Mine Rescue Car 411
Ohio Notes 55

Page

Ohio, Panel System in..... 562
Ohio, Proposed Mining Legislation 396
Ohio's Foolish Mine Laws..... 524
Oil-Driven Air Compressors 778
Oil in Air Receivers 768
Oil, Practical Lubricating Tests..... 687
Oil, Purchase of Lubricating..... 357
Oils, Cost of Cylinder..... 575
Oil Scum 125
Oil, Specifications for Lubricating..... 314
Old Freibergers in America..... 402
Old Timer, Some Reflections 768
Oliver, Albert E. 590
Oklahoma, Law in Regard to Mine Telephone 106
Oklahoma Undercutting Law Repealed..... 180
O'Neal, Frank E., Coal Fields of Jasper Park, Alberta, 399—Smoky River Coal Field 346
Oneida Drainage Tunnel..... 142
Opening Nova Scotia Coal Mines..... 595
Open Lights in Well-Ventilated Mines..... 700
Operating Induction Motors 669
Orenstein-Arthur Koppel Co., Advantages of Steel Mine Cars 172
Origin of Coal 271, 351
Oster Mfg. Co., "Bulldog" Die Stock..... 327
Ottumwa Iron Works, Wire Rope Haulage 173
Our Cover Picture 132
Our Supplement 131
Output, Cost of Mining as Related to..... 158
Output of Anthracite in 1913..... 767
Overwinding, Prevention of..... 145
Oxidation of Coal 315

PACKER NO. 5 MINE FIRE..... 553
Packing, Relation of Subsidence to.... 87
Palmer, Leroy A., Western Montana Coal Fields 721
Panama Pacific Exposition, Coal at..... 313
Panama Pacific Exposition, Mining Exhibit 424, 462
Panel System in Ohio..... 562
Panther Valley Mining Institute, October, 1913 286
Paradise Coal Co., Coal Preparation on the Marcus Screen 775
Parker & Bridge 198
Parker, Edw. W., Cost of Coal Mining..... 281
Parrish, J. F., Burning Low-Grade Anthracite 567
Passing of the Mine Mule..... 198
Patton, Robt. H., Capacity of Car.....513, 573
Pennsylvania Anthracite Section of A. I. M. E. 631, 701
Pennsylvania Bituminous First-Aid Meet, 1913 220
Pennsylvania Coal Co., Pumping Out Schooly Mine 728
Pennsylvania-Hillside Contest, 1913..... 221
Pennsylvania, Lowest Coal Bed in..... 429
Pennsylvania Notes 55, 196
Pennsylvania Railroad, Coal Loading Methods 745
Perkins, Frank C., Pyrene as a Fire Extinguisher 507
Permissible Explosives, Advances in..... 111
Perolin, Feedwater Difficulties 714
Perolin for Boilers 649
Personal Equation, The 632
Person and a Personality, A..... 587
Petros Coal Co., Mining Plant of..... 151
Philadelphia & Reading, East Brookside Mine Disaster, 66, 101—Complete Mine Maps, 91—First-Aid Meet, 1913, 215—Maple Hill Haulage, 143—New Executive, 690—Porcupine Column-Pipe Cleaner, 357—Method of Handling Rock 765
Philadelphia Industrial Exposition..... 65
Phthisis, Miners' 634
Pictures as Aid to Mine Accident Prevention, Moving 97
Pictures for Accident Prevention, Moving.. 495
Pillar Drawing 313, 442

Page

Pillars, Circular 396
Pillars, Machine Mining in Room 591
Pipes, Capacity of 501
Pipes, Fiber or Paper Air 442
Pitkin, S. H., Rope Haulage Systems 174
Pittsburg, American Mine Safety Contest .. 207
Pittsburg Coal, Weathering of 744
Plumb-Bob for Shaft Plumbing 96
Plumbing a Shaft 543
Plumbing, Shaft 95
Pneumelectric Machine Co., New Room Hoist 454
Pocahontas Coal 197
Pocket Mining Hygrometer 391
Pond Creek Coal Co 602
Ponies, Protection of Pit 169
Porcupine Column-Pipe Cleaner 337
Portable Air Compressors 260
Portable Brattice Cloth 611
Portable Substation for a Coal Mine 454
Powder Can, Safety 455
Power, Cost of, Calgary 56
Power Used in Anthracite Mines 161
Practical Lubricating Tests 687
Practical Man's Way 76
Practical Mining Course, University of Tennessee 706
Practical Mule Haulage 166
Practical Talks on Coal Mining 43, 112, 182, 246, 307, 387
Pratt, H. D., Making the Truck Pay 646
Precautions, American Coal Dust 739
Preparation of Coal 51
Pressure and Velocity Meter in Mines 300
Prevention of Accidents 573
Prevention of Coal-Dust Explosions 10, 395
Prevention of Haulage Accidents 169
Prevention of Overwinding 145
Price, William Z., Acetylene Lamps in Coal Mines, Experiments, 49—Alabama Coal Operators' Association July, 1913, Meeting, 69—American Mine Safety Association, First-Aid Contest, 207—Brookside Mine Disaster, 101—Compressed Air Mine Haulage, 143—Furnace Run Mines, 333—Mining at Lowe, W. Va., 433—Mining in Eastern Kentucky 530—New Weston Colliery, 726—Pond Creek Coal Co., 602—Rope Haulage at Vesta No. 4 Mine, 135—Short Mountain Breaker, 267—Steel Corporation Mines at Gary, 463—Stripping in Anthracite Region 655
Priming the Shot 622
Prize Contest 38, 119, 177, 296, 322, 359, 378, 444, 511, 579, 640
"Pro Bono Publico" 197
Producer Gas Engines in a New Field 176
Production of Stone Dust in Collieries 90
Production per Man, Various States 634
Professionalism 199
Promotions, Important and Deserved 766
Proposed Mining Legislation in Ohio 396
Pro's and Con's on Coke Manufacture 312
Prospecting Bering River Coal Field 347
Prosperity in the Coal Fields 198
Protection of Pit Ponies 169
"Proto"-Fleus-Davis Apparatus 63
Pump, A New Mine 648
Pump, Goulds Portable Mine 715
Pumping 513
Pumping Coal 381
Pumping Coal to Market 381
Pumping Out a Mine 728
Pump, Self-Contained Portable 715
Puncher Machine 79
Purchase of Lubricating Oil 357
Put the Blame Where it Belongs 265
Pyrene as a Fire Extinguisher 507
Pyrite in Coal 2

QUAKE—NO EXPLOSION 459
Qualifications for Certificate in Alberta 635, 700
Quickel, R. D., Clinkering of Mixed Coals 368
Quinn, Patrick 590

Page

RADIUM LANDS 228
Randolph, Beverley F., Animal Haulage in Mines 139
Rankin, George, Method of Mining Wanted 635
Ravenswood Explosion 607
Real Heroism 382
Record, Large Coal Output, Illinois 575
Record of Mansfield Colliery 311
Record, Truesdale Breaker 324
Recovering Oil and Waste 505
Rectangular Coke Oven Plant 683
Red Cross Muckle Cup Contest, 1913 211
Reese, John P., Mine Safety Association 382
Reference Books at Examinations 2
Reflections, Some 768
Regulation, As to Business 331
Regulator, Location of 38
Relation of Subsidence to Packing 87
Reminiscences of the Schuylkill Region 156
Report of English Explosions in Mines Committee 92
Reports, Uniformity in Inspectors' 565
Reports, Uniformity in State Mine Inspectors' 524
Rescue Brigades, Training of 678
Rescue Car, Ohio Mine 411
Rescue Organization, German 284, 355
Rescue Work at British Mines 2
Rescue Work Instruction 573
Rescue Work, Telepathy in 571
Responsibility 719
Resuscitation, Schaefer Method of 53
Reynolds, Wm. H. and Sim, Robbing Mine Air of its Danger 659
Rheolaveur Coal Washer 555
Rice Gasoline Rock Drill 260
Rice, Geo. S., American Coal Dust Precautions 739
Richards, Joseph W., Carbon Monoxide Not a Supporter of Combustion 38
Richards, W. J., Biography 690
Rickard, T. A., Mining Malaise 66
River Tipple, Movable 736
Roberts, Jr., W. H., Carrying the Meridian Underground 95
Robbing Mine Air of its Danger 659
Robinson, Neil, The Mineral Man 632
Rock Drill Operated by Gasoline Engine 519
Rock, New Method of Handling 765
Rock Plane, A New 686
Roderick, Jas. E., Rules for Prevention of Accidents 429
Roller Bearings for Mine Cars, Sells 520
Roller Bearing Wheels 712
Roof of Flooded Mine, Effect of Dewatering 381, 441
Roof Support 396
Roosevelt, Theodore, Force vs. the Constitution 718
Rope Haulage at Vesta No. 4 Mine 135
Rope Haulage Systems 174
Rope Lubrication 441
Rosbottom, Frank, Flooded Coal Mine in Illinois 570
Rotary Drills, Air Hammer vs. 554
Rotary Power Pump 128
Royersford Foundry and Machine Co., Sells Roller Bearings 520
Rules, Breaking Colliery 719
Rules for Prevention of Accidents 429
Rutledge, J. J., Ventilating Mines and Removing Gas 81

SAFEGUARDING ELECTRICITY IN MINES 619
Safety Application of Swing-Gate Valve 644
Safety Boosting Banquet, Annual 440
Safety Calendars 458
Safety First 236
Safety First 718
Safety Gates for Shafts 162
Safety Lamps, Test of 108
Safety Powder Can 455
Safety Sign, New Mine 236
Saline County First-Aid Meet 692

Page

Salt in Ocean 674
Salt, W. G., Notes on Haulage Clips 425
Same Old Story 198
Samples, Selection of Coke 363
Sand by Compressed Air, Conveying 108, 312
Sanford-Day Iron Works, Roller Bearing Wheels 712
Scabs 197
Schaefer Method of Resuscitation 53
Schellenberg, Frank C., Reminiscences of the Schuylkill Region 156
Schmidt, Oscar C., Safety Application of Swing-Gate Valve 644
Scholz, Carl, Gasoline Mine Locomotives, 153—Steel in Mine Construction 30
Schools, Closing Exercises, Lehigh Valley Coal Co. 25
Schools, Miners' Vocational 235
Schooly Mine, Pumping Out 728
Schroeder, J. A., Hyatt Roller Bearings Applied to Mine Cars 173
Schuylkill Region, Reminiscences of 156
Science and Industry Allied 630
Scobee, Barry, Strip-Pit Mining in Kansas 232
Scranton Coal Co., Mt. Pleasant Bath House 354
Scranton Mining Institute, November, 1913 375
Selection of Coke Samples 363
Selection of Induction Motors 544
Self-Contained Portable Pump 715
Self-Rescuing Apparatus 585
Selling Price of Coal 412
Sells Roller Bearing for Mine Cars 520
Seneca, Automatic Mine Door at 360
Settlement, Common Sense Regarding Surface 459
Shaefer, J. V., Coal Preparation on the Marcus Screen 775
Shaft, Carrying the Meridian Down 543
Shaft-Gate Controlling Device 399
Shaft Plumbing 95
Shafts, Safety Gates for 162
Shaft Sinking, Cementation Process 234
Shaft Sinking in Wet Ground 108
Shaft Stairway 714
Shanks, John, "Bumps" Their Cause and Effect 551
Shannon, C. W., Oklahoma Undercutting Law Repealed 180
Sharp, Alexander, Longwall Method of Mining 486
Shearer, David R., Cooperative Central Station Possibilities 502
Sherman Law, Bituminous Coal Industry and 569
Shoemaker, G. M., Acetylene Lamp Difficulties 109
Shooting Off the Solid 321
Short Mountain Breaker 267
Shortwall Machines 7
Should Exhaust Steam Be Wasted? 41
Shubart, Benedict, Single-Motor vs. Two-Motor Types of Mine Locomotive 441
Siberian Collieries 73
Single-Motor vs. Two-Motor Types of Mine Locomotives 441
Signaling in Gassy Mines 175
Sign, New Mine Safety 236
Silk from Wood 125
Simplex Construction Co., The Simplex System 647
Sinking Shaft, Cementation Process 234
Sinking Shaft in Wet Ground 108
Slack Bin, Steel 518
Slack, Methods of Utilizing Small Coal and 658
Slope Haulage at Sayreton, Ala 155
Smoky River Coal Field 346
Some Reflections 768
Somerset Mine, Utah Fuel Co 667
Specifications for Lubricating Oil 314
Spitzbergen Coal 337
Splint, Stewart Broken Back 32
Sprayer in Northumbria, An Efficient 145
Springer, J. F., Coal Loading Methods 745
Stag Cañon Fuel Co. Dawson Mine Disaster 365

Page

St. Michael, Four-Decked Cage at..... 5
Stairway, Shaft 714
Standard of Ventilation..... 526
State Interference in British Mines..... 738
Steam Be Wasted? Should Exhaust..... 41
Stearns Coal and Lumber Co., First-Aid Contest, 1913 210
Steel Corporation Mines at Gary..... 463
Steel in Mine Construction..... 30
Steel Mine Cars, Advantages of..... 172
Steel Slack Bin 518
Steel vs. Iron Boiler Tubes..... 622
Stewart Broken Back Splint..... 32
Stine Duplex Pump, J. C..... 649
Stock, H. H., Why Technical Editors Seek Euthanasia 420
Stone Dust in Collieries, Production of.... 90
Stone Dusting in Dusty Coal Mines..... 574
Stone, Kentucky, Pond Creek Coal Co..... 602
Stop, Automatic Chute..... 474
Stop, Hinkel Automatic Safety..... 714
Storage Battery Locomotive..... 146
Storage Battery Locomotives..... 646
Strange Accident 765
Stretcher, Williams Mine..... 457
Strikes in Violation of Contract..... 366
Stripping in Anthracite Region..... 655
Strip-Pit Mining in Kansas..... 232
Strohm, R. T., Mechanics of Mining..... .....43, 114, 184, 246, 307
Subsidence to Packing, Relation of..... 87
Successful Miners' Course..... 698
Sullivan Machinery Co., Portable Air Compressors 260
Sulphur in Coal 2
Summit Branch Mining Co., Short Mountain Breaker 267
Superior Coal Co., Record..... 630
"Suppose Miner" 598
Surveys, Kentucky System of Land..... 675
Susquehanna and Allied Companies, First-Aid Meet, 1913 216
Switch, Frogless 154
Sylvester, G. F., Tennessee Mining Law.... 312

TACHOMETER, BRISTOL'S PNEUMATIC TYPE RECORDING..... 582
Taffanel, J., International Study of Coal-Dust Problem 688
Tamping for Greater Safety in Blasting, Method of 321
Tapes, Improved Measuring..... 521
Taxation of Anthracite Seventy Years Ago 306
Taxation of Coal Lands..... 437
Tax on Anthracite 197
Taylor, James, Fire Protection of Mines.... 28
Taylor, Samuel A., Fiber or Paper Air Pipes 442
Technical League of America..... 685
Technical Reports, Lecture on..... 682
Telepathy in Rescue Work..... 571
Telephone, Equipment for Mine Recovery.. 62
Telephone, Oklahoma Law 106
Telephone System, Underground..... 238
Temple Iron Co..... 706
Temple Iron Co.'s Collieries, New Owner.. 689
Tennessee Coal Output, 1913..... 621
Tennessee Mining Law 312
Tennessee University Mining Course..... 706
Terry Steam Turbine Co..... 522
Testing for Carbon Monoxide..... 14
Testing for Firedamp with Wire Loop..... 344
Tests of Bering River Coal Unfavorable.... 395
Test of Safety Lamps, Beard-Mackie..... 108
Texas Coal Mining Outlook..... 324
Texas, Lignite Mining at Hoyt..... 93
The Force That is Molding a World..... 651
Then and Now..... 620
Thompson, A. E., Practical Mule Haulage.. 166
Thorne, S. Brinkerhoff, New Owner of Temple Iron Co.'s Collieries..... 689
Thurmond Coal Shipments, 1913..... 413
Timber Hook, The Eureka..... 126
Timbers, Aczol Process of Preserving..... 674
Timbers, Treating Mine..... 543

Page

Timely Suggestion 238
Tipple, A Brick 527
Tipple, Black Diamond Concrete..... 475
Tipple, Movable River 736
Tool for Miners, Combination..... 648
To Prevent Mine Doors Being Left Open.. 431
Tornow, Bergassessor Doctor, German Coal-Dust Precautions 533
Track, Portable Branch..... 611
Tracks, Mine 152
Training of Rescue Brigades..... 678
Tread Mills 316
Tree Planting in Sand Dunes..... 188
Tree Species in United States..... 484
Trouble in Colorado..... 703
Truck, A New Mine Car..... 583
Truck Pay, Making the..... 646
Truesdale Breaker Record..... 324
Tupper, C. A., Operating Induction Motors, 609—Selection of Induction Motors..... 544
Turbines for Operating on Exhaust Steam, Connecting Steam 60

UNDERCUTTING WITH PICKS..... 79
Underground Telephone System..... 238
Underground Rubbish Car..... 180
Unfair Criticism of Bureau of Mines..... 589
Uniformity in Inspectors' Reports..... 565
Uniformity in State Mine Inspectors' Reports 524
U. S. Graphite Co., Feeding Graphite to Boilers 392
Unusual Accident 228
Uplift in West Virginia..... 486
Use of Naphthalene in Coal Briquets..... 564
Utah Fuel Co., Somerset Mine..... 667
Utah's Lofty Mountains 744

VALUATION OF FUELS, EFFICIENCY Value of Coal Analyses..... 23 242
Vandalia Coal Co., First-Aid Contest, 1913.. 210
Van Hise, Charles R., Big Business and Mining 694
Ventilating Mines and Removing Gas..... 81
Ventilation and Fire..... 700
Ventilation, Gases and..... 635
Ventilation, Mine..45, 112, 186, 248, 308, 390, 452
Ventilation, Standard of..... 526
Ventura Fans 194
Verner, John, Is Anthracite Dust Explosive? 109
Vesta No. 4, Rope Haulage at..... 135
Victor, David, How to Handle a Dry or Dusty Mine 99
Victor-American Fuel Co., First-Aid Meet, 1913 214
Virginia Coal Output, 1912..... 32
Virginia Coal Production, 1912..... 111
Virginia Railway Pier 745
Visiting Coal Mines..... 523
Volf, G., Method of Tamping for Greater Safety in Blasting 321

WALKER, SYDNEY F., CEMENTATION PROCESS FOR SINKING SHAFT, 234—Electric Mine Gas Detectors..... 604
Wanton Destruction of a Large Mexican Coal Mine 132
Warning 263
Washer, Rheolaveur Coal..... 555
Washington, Coal Creek Mine..... 18
Washington, Issaquah Coal Mine..... 663
Waste in Coking..... 74, 96
Water, Density of..... 245
Water, Hard and Soft..... 363
Water Shelves 30
Water Softeners 233
Water, Useful Information..... 510
Water, Weight of..... 328
Watson, A. S., Storage Battery Mine Locomotives 646
Watteyne, Victor, Belgian Coal Dust Precautions 599
Watt Mining Car Wheel Co., Efficiency in Mine Haulage 171

Page

Weathering of Pittsburg Coal..... 744
Webb, H. S., Electricity in Mines..... .....47, 116, 182, 247, 309, 387
Welch Hoisting Engine Controller..... 456
Welch Overwinding Device..... 145
Welfare Work at Grant Town, W. Va... 724
Welfare Work of Kingston Coal Co..... 497
Wellman-Seaver-Morgan Co., Rope-Haulage Systems 174
Wells, Francis G., Pumping Coal to Market 381
Western Electric Co., Mine Recovery Telephone Equipment 62
Western Kentucky Coal Mine..... 414
Western Montana Coal Fields..... 721
Westinghouse Electric and Mfg. Co., Large Electric Hoist 456
Weston Colliery, The New 726
West Virginia Coal 580
West Virginia Coal Mining Institute, December, 1913 283
West Virginia Mine Inspectors..... 738
West Virginia Mining Institute, June, 1914, Meeting 760
West Virginia Mining Institute, December, 1913 374
West Virginia Mining Institute, June, 1913 56
West Virginia's Compensation Act..... 228
West Virginia, The Mineral Man..... 632
West Virginia, Uplift in..... 486
Weyanoke Coal and Coke Co..... 433
Weyanoke Coal and Coke Co., New Wrinkle in Cutting Coal..... 192
Weyanoke, Prize Gardens at..... 359
What Do You Want? 717
What is a Fatal Mine Accident?..... 329
What is Coal Land?..... 224
What is Dynamite Anyhow?..... 181
What Next? 458
What the Large Anthracite Companies Have Done 132
Wheatley, Robt. S., Is Carbon Monoxide a Supporter of Combustion?..... 38
Wheeling Creek, Explosion Not Caused by Acetylene 702
Wheeling Tent and Awning Co., Williams Mine Stretcher 457
Whitwick Colliery, Coal Breaker at..... 402
Why Technical Editors Seek Euthanasia... 420
Willey, Day Allen, Briquet for Saving Fuel Waste 417
Williams Mine Stretcher..... 457
Williams Valley Mining Institute..... 270
Wing Turbine Blower, New..... 776
Wilson, E. B., Natural History of Coal Dust 689
Wire Loop, Testing for Firedamp With..... 344
Wire Rope Haulage..... 173
"Wisest Man, The"..... 381
Women's First-Aid Team..... 221
Woodward-Pettebone First-Aid Contest, August, 1914 700
Working an Inclined Coal Bed..... 18
Working Days Per Year, Miners'..... 699

Index B—Book Review

AMERICAN RED CROSS ABRIDGED TEXTBOOK ON FIRST AID..... 508
Application of Electricity to Mines..... 254

BLACK POWDER AND DYNAMITE.... 118
Bulletin 2, Coal Mining Practice, in District 8, Illinois..... 711
Bureau of Mines, Washington..... 509

CARNEGIE POCKET COMPANION, SIXTEENTH EDITION 509
Catskill Water Supply..... 40
Chain Grate Stoker and Steam Superheaters 774
Colliery Managers' Pocketbook, Almanac and Diary, 1914 432
Compressed Air 711
Cyanidation in Mercur..... 380
Cyanide Process, The..... 170

Page

ECONOMIC GEOLOGY 432
Electrical Blue Book, 1914..... 432
Electrical Pocket Book, 1914..... 508
Electric Furnace, The..... 561
Emery's Miners' Manual 643
Engineering Geology 774
Engineering Index Annual, 1913..... 561
Excavating Machinery 118

GENERAL METALLURGY 118
Gold Dredging 311
Gold Prices and Wages..... 380

HEATING AND VENTILATION..... 508
Heaton's Annual of Canada 508
Hendrick's Commercial Register..... 255
History of the E. I. du Pont de Nemours Powder Co. 170

IGNEOUS ROCKS, VOL. 2..... 170
Improved Methods of Connecting Small Turbines in Steam Power Plants and Exhaust Heating and Drying System... 170
Index of Current Literature, Vol. 3, Mining World 255
Iowa Geological Survey, Vol. 22..... 311
Iowa Geological Survey, Bulletin No. 4.... 509

MARYLAND GEOLOGICAL SURVEY... 311
Mechanical World Pocket Diary and Year Book 508
Metal Statistics 509
Mine Surveying 381
Mineral Deposits 254
Mineral Springs of Georgia..... 118
Mining Engineers' Examination and Report Book 311
Mining World Index of Current Literature, Vol. 4 643
Missouri Bureau of Geology and Mines.... 643

NORTH COMPANY COAL AND SHIPPING ANNUAL 432

O'HARRA'S HANDBOOK OF THE BLACK HILLS 380

PENN STATE MINING QUARTERLY, VOL. 1 508
Properties of Saturated and Superheated Ammonia Vapor 39

RESUSCITATION 39
Rock Excavating and Blasting..... 711

SAFETY IN COAL MINES 255
Steam Consumption of Locomotive Engines from Indicator Diagram..... 40
Steam, Its Generation and Use..... 254
Steam Power Plant Engineering..... 118
Steam Turbines 39
Steel Mill Building..... 170
Study of Igneous Rocks..... 255

TENNESSEE MINING DEPARTMENT, Report, 1912 432
Topographic and Geological Survey of Pennsylvania, 1910-1912 432

UNIVERSITY OF KANSAS SCIENCE BULLETINS 381

WEST VIRGINIA GEOLOGICAL SURVEY 255, 380, 774

Index C—Personals and Obituaries

ABSALOM, JOHN I..... 654
Affelder, W. L..... 68
Albaugh, Morris 506
Alexander, Wm. 200
Allen, J. B..... 200
Allen, William L..... 506
Allport, J. H..... 525
Andersen, James (Obit.)..... 672
Anderson, James 589
Anderson, Jr., Robert Y..... 200
Andrews, C. A..... 719
Andros, S. O..... 4, 200

BACK, THOS. 506
Baer, George F..... 654
Baer, George F. (Obit.)..... 673
Bardell, M. M..... 332
Barlow, Dr. A. E. (Obit.)..... 770
Bashore, Charles 68
Bayless, F. P..... 68
Bayne, Geo. 398
Beck, Dr. Richard 134
Bell, John A..... 720
Berwind-White Coal Mining Co..... 332
Berwind, E. J..... 200
Besler, W. G..... 654
Beveridge, A. 590
Blair, J. W..... 200
Blenkinsopp, L. 4, 200
Boileau, John W..... 4
Botting, David C..... 398
Boyer, M. H..... 654
Bradley, F. W..... 525
Brennan, M. J..... 4
Brewer, W. 68
Brinsmade, R. B..... 507
Brock, Reginald W..... 525
Brown, Harry 654
Brown, W. J..... 398

CALLOWAY, A. W..... 530, 720
Calverley, Walter R..... 266
Cameron, Henry 720
Campbell, W. W..... 200
Carraher, T. A..... 200
Carson, S. A..... 507
Carver, Enoch 200
Cassingham, C. L..... 719
Christy, Prof. S. B..... 526
Claghorn, Clarence R..... 398
Clark, Harry B..... 719
Clark, J. A..... 719
Clere, Raymond D..... 200
Clifford, Wm. 68, 134
Cobb, E. B..... 200
College of Engineering..... 200
Collins, C. P..... 4
Connell, Edgar 590
Conner, Eli T..... 506
Consolidated Indiana Coal Co..... 720
Cook, J. M..... 526
Copeland, F. K..... 654
Cornet, F. C..... 68
Corrigan, Edward J..... 507
Cox, G. L. 525
Coxe, Edward H. 4, 590
Crane, W. R..... 68, 266
Cunningham, F. W..... 506
Cunningham, J. A..... 720

DALRYMPLE, JAMES 4
Davey, John E..... 200
Davidson, G. M..... 654
Davidson, Henry T..... 720
Davidson, J. R. 507
Davies, Hywel 398, 654
Davies, James B. (Obit.)..... 629
Davies, L. W. 398, 589
Davis, D. J. 398
Davis, M. T. 398
Dean, J. W. 507
Dean, Samuel 720
Denman, Heher 506
De Saulles, C. A..... 68
Devlin, Thos. 506
Devoy, Edward 590
Dilworth, J. B. 720
Dodson, Truman M..... 68
Donaldson, R. T. 526
Dorrance, Jr., Charles 507
Douglass, H. B..... 4
Drenner, E. 654
Drinker, Henry S. 506
Drown, D. W..... 506
Dunbar, Frank 525
Dunbar, F. H..... 526

EAST JELLICO COAL CO..... 720
Eaton, Samuel B..... 398
Eiker, Charles F..... 720
Evans, David T..... 398
Evans, George Watkin..... 266, 590
Evans, W. W. 266

FAIRBURN, JOS. 506
Feehan, Francis 200
Fitzgerald, President 68
Flanagan, E. J. 266
Flanagan, John M. 719
Fletcher, Garner 719
Fohs, F. Julius 134
Forbes, J. M. 506
Forester, Jas. 200
Freese, T. A. 4
Frew, Archibald 506
Frey, R. M. 4
Fritchman, Frank M. 200
Fuller, John T. 200

GALLOWAY, J. W..... 719
Gannon, R. E. 68
Gard, Irving R. 525
Garvin, W. O..... 654
Gillespie, R. H. 720
Gilman, Walter 720
Glenn, Geo. B. 266
Gobey, F. E. 526
Goddard, W. H. 506
Goedecke, A. O..... 398
Gould, F. J. 134
Grelley, Wm. 68
Grove, W. G. 4

HAHMAN, WILLIAM 654
Hall Clarence 398
Hammonds, J. S..... 332
Hanlon, W. T. 589
Hannah, J. O. 200
Hardie, W. D. L..... 506
Hardy, Paul 200
Harrison, George (Obit.)..... 111
Harry, S. J. 507
Hartman, William 506
Hartshorne, Geo. 398
Harvey, Thos. 134
Hawkins, E. N. 398
Hawkins, Wm. P..... 4
Healy, J. F. 4, 200
Hibline, J. Edward 507
Hill, F. A. 398
Hills, Victor G. 398
Hinterleitner, H. J. 4
Hirsch, H. H. 590
Hitchcock, C. I. 720
Hoffman, Charles 200
Hogan, Patrick 506
Holbrook, Elmer A..... 134
Holland, Wm. 134
Holliday, L. B. 200
Huber, Charles F. 654
Hunt, John 654
Hunt, Robt. W. 654
Huntoon, L. D. 68

ICE, CHAS. F. 506
D'Invilliers, E. V. 332, 526, 720
Ireland, G. W. 654

JACKSON, T. A. 68
Jeffrey, J. W. 719
Jeffreys, J. E. 68
Jenkins, Thos. M. 398
Jenkins, W. J. 4
Jermyn, Edmund B. 332
Jones, Charles 589
Jones, F. A. 654
Jones, Sheldon 332
Joyce, Edwin 506

Page

KANEY, JOHN 506
Kauffman, A. 134
Keeley, Josiah 506
Keen, W. L. 525
Keiser, Geo. 398
Kelley, A. B. 266
Kelsey, E. E. 590
Kentucky-Harlan Fuel Co. 720
Kregor, Orville 506

LAING, JOHN 134
Lambert, E. C. 200
Lamont, William 525
Late, Gordon B. 506
Lehigh Valley Coal Co. 32
Lewis, Greenville 590
Lindsey, K. C., George G. S. 590
Ling, Chas. 332
Lockhard, Ralph 506
Long, Elmer O. 332, 398
Longyear, Hon. John Munro 590
Louttit, H. B. N. 506
Lukins, F. W. 398
Lynch, Major Charles 200

MCALLISTER, HECTOR 506
McClintock, John 506
McGhee, D. H. 525
McKee, W. M. 720
McOlvin, E. P. 4
MacEwan, W. H. 4
MacFarlane, A. D. 68
Macfarlane, Malcolm 68, 398
MacIntosh, John F. 200
Maize, Richard 506
Maloney, Robert B. 507
Mangan, William 68
Manley, B. P. 720
Markell, F. E. 507
Marsee, J. B. 720
Martin, Edward I. 654
Martin, James 200, 590
Meehan, H. J. 590
Mellinger, L. O. 506
Mengle, W. A. 398
Menzies, J. F. 266, 398
Miles, A. D. 134, 68
Miller, Arthur R. 266
Miller, Harry R. 506
Mitchell, Arthur 200
Monongahela Coal Co. 719
Morgan, C. T. 68
Morgan, Geo. 506
Morgan, Iva M. 68
Morris, John T. 4
Muir, R. Y. 200
Murray, Isaac 332

NEALE, ARTHUR 590, 506
Nelson, H. A. (Obit.) 111
Nesbitt, C. H. 654
Newsam, Richard (Obit.) 110
Nichols, H. W. 654
Nicol, Wm. H. 200
Northover, Joseph 654

O'BRIEN, T. H. 525
Orme, P. 398
Orner, A. Verner 506
Ott, J. E. 68
Ott, Lee 68

PALMER, LEROY A. 4
Parker, Richard A. 398, 525
Parmelee, H. C. 398
Parsons, Frank E. 200
Patterson, C. L. 590
Patterson, George (Obit.) 572
Peale, Rembrandt 4
Peck, Chas. Lathrop 332
Phillips, John 266
Pinckney, H. H. 590
Plaster, W. B. 200
Pollard, John H. 398
Powell, Col. Louis W. (Obit.) 324
Powell, J. W. 68, 654

Page

Prosser, Thos. 398
Purser, B. E. 720

RAFFERTY, M. J. 266
Rash, Frank D. 720
Ratchford, M. D. 506
Reese, Benjamin 590
Rhys, R. T. 68
Richards, Prof. Robert H. 720
Richards, W. J. 398, 654
Riggleman, W. B. 266
Rittenhouse & Sons, J. H. 720
Roan, John M. 506, 719
Robertson, Andrew (Obit.) 241
Robey, T. F. 719
Robinson, Neil 589
Robson, T. J. 398
Rocky Mountain Fuel Co. 506
Roderick, Jas. F. 266
Rogers, R. S. 507
Roth, Roht. F. 134
Rutter, Frank B. 134

SCHMICK, W. L. 4
Schneider, Rudolf J. 200
Schoen, Karl 266
Schoew, Frank F. 200
Searls, E. C. 398
Sharp, Harry 68
Shaw, Jas. 200
Shields, Dr. M. J. 200
Shindel, Charles S. (Obit.) 40
Shoemaker, Geo. M. 525
Shook, J. W. 200, 266
Shumway, E. E. 507
Simpson, Jas. D. 506
Skeath, John (Obit.) 446
Skinner, J. D. 398
Smith, J. A. 200
Smith, Jas. B. 525
Snyder, Baird, Jr. (Obit.) 40
Southern Appalachian Coal Operators' Association 654
Starks, J. W. 506
State Mining Board of Illinois 332
Stearns, Thos. B. 398
Stein, William (Obit.) 446
Stevenson, Dr. John J. 720
Stock, Prof. H. H. 4, 590
Stoker, J. J. 332
Storrs, William H. (Obit.) 371
Stotesbury, E. T. 654
Struthers, Joseph 720
Sullivan, D. H. 506
Summit Branch Mining Co. 200
Sweeney, E. R. 4
Sweeney, Edw. 68
Swetner, C. F. 720
Sylvester, George 4

TENER, GOVERNOR 200
Thomas, W. A. 720
Thomas, Willis P. 720
Thompson, C. H. 4
Thropp, Jr., J. E. 590
Thrush, David 506
Thyng, W. S. 68
Timmerman, L. F. 526
Tormay, Patrick J. 332
Troutman, Greyson P. 398
Trumbull, L. W. 266
Tschetschott, Prof. Henry 525
Tye-Wheeler Coal Co. 506

UNDERWOOD, WILLIAM 68

VAUGHN, L. D. 200
Veazey, V. S. 525
Von Bayer, A. H. 200
Voorhees, Theodore 654
Voyles, Andrew 720

WAGGENER, C. H. 719
Walker, Sydney F. 720
Waters, John E. (Obit.) 572

Page

Westinghouse, George (Obit.) 620
White, E. S. 134
Wilhoit, Roy 720
Wood, A. H. 590
Woodson, C. C. 68
Wooley, Jabez 200

YATES, HARRY 200
Yingling, M. G. 720
Young, Judge A. W. 200
Young, Prof. Lewis E. 4, 134

Index D—Catalogs Received

ALBANY LUBRICATING CO. 64, 202
Allan American Maganese Steel Co., Edgar 196
Allis-Chalmers Mfg. Co. 262
American Blower Co. 522
American Concentrator Co. 328, 780
American Fuel Saving Co. 586, 196
American Pulverizer Co. 328
American Rolling Mill Co. 710
American Safety Lamp and Mine Supply Co. 64, 780
Armstrong Cork Co. 130, 458, 643
Asbestos Protected Metal Co. 196
Automatic Reclosing Circuit Breaker Co. 780

BACHARACH, HERMAN 711
Baldwin Locomotive Works 64, 262, 458, 710, 780
Bartlett & Snow Co., C. O. 394
Bausch & Lomb Optical Co. 394
Bayley Mfg. Co. 780
Bittenbender Mfg. Co. 458
Blake & Knowles Steam Pump Works 196
Borden Co. 328
Brennan Drilling Co., J. A. 130
Bristol Co., The 196, 262, 328, 643, 780
Buckbee & Co., J. C. 394
Buff & Buff 394, 522
Builders Iron Foundry 196
Burt Mfg. Co. 710
Busch-Sultzer Bros.—Diesel Engine Co. 711

CAMERON STEAM PUMP WORKS, A. S. 64
Canton Hughes Pump Co. 394
Carnegie Steel Co. 780
Central Foundry Co. 522, 643
Chicago Bridge and Iron Works 711
Chicago Pneumatic Tool Co. 130, 196, 262, 328, 458, 586, 643, 710
Cleveland Rock Drill Co. 458
Continental Car and Equipment Co. 64
Cyclone Drill Co. 780

DAUM CO., A. F. 64
Davis Instrument Mfg. Co. 196, 394
Dean Steam Pump Co. 522
De La Vergne Machine Co. 328
Denver Engineering Works Co. 328
Dixon Crucible Co., Jos. 458
Draeger Oxygen Apparatus Co. 394, 643
Du Pont de Nemours Powder Co., E. I. 328

ELECTRIC STORAGE BATTERY CO. 780

FAIRBANKS, MORSE & CO. 710
Fairmont Mining Machinery Co. 328
Fiber Conduit Co. 458
Formastat Mining Co. 394
Fulton Pit Car Co. 394

GARDNER GOVERNOR CO. 64, 458, 522
General Electric Co. 262, 328, 394, 522, 643, 710
Goldschmidt Thermit Co. 64, 458
Goulds Mfg. Co. 64, 130, 710
U. S. Graphite Co. 328, 394
Gray Engineering Co. 711
Gun-crete Co. 780

Page

HAYTON PUMP CO. 711
Hayward & Co., S. F.....262, 522, 586
Hazard Mfg. Co.....458, 711, 780
Helmick Foundry and Machine Co..... 711
Herzler & Henninger Machine Works..... 586
Hess-Bright Co.....196, 586, 643, 780
Highland Chemical Products Co..... 710
Hockensmith Wheel & Mine Car Co..... 196
Hyatt Roller Bearing Co..... 586

IMPROVED EQUIPMENT CO..... 64
Independent Powder Co..... 394
Industrial Instrument Co.....262, 711
Ingersoll-Rand Co. 64, 130, 196, 262, 328, 394, 458, 780
Ironsides Co. 458

JEFFREY MFG. CO.....130, 196, 710, 780
Johns-Manville Co. 458

KEYSTONE DRILLER CO. 64
Koehler Mfg. Co..... 458
Kolesch & Co. 262

LAIDLAW, DUNN-GORDON CO..... 522
Lidgerwood Mfg. Co..... 64
Link-Belt Co. 64, 780
Lunkenheimer Co. 394, 780

MCMYLER INTERSTATE CO. 710
Marion Steam Shovel Co. 522
Merrell Mfg. Co. 643
Mesta Machine Co. 262, 328
Milwaukee Locomotive Mfg. Co.....196, 394
Monighan Machine Co. 394
Morgan-Gardner Electric Co.....522, 710, 780
Morris Machine Works 196

NATIONAL PULVERIZER CO. 196
National Tube Co. 196, 262, 328, 458, 522, 586, 643
Nelson Valve Co. 458
Northern Conveying Machine Co..... 262

OHIO BRASS CO.....64, 196, 394, 780
Orenstein-Arthur Koppel Co. 262
Ottumwa Iron Works 780

PENNSYLVANIA CRUSHER CO. 394
Platt Iron Works Co.....394, 522
Plock, A. F. 586, 710
Pneumelectric Machine Co. 458
Powell Co., Wm.....196, 262, 458, 522, 586, 711
Prescott Steam Pump Co..... 196

REVERE RUBBER CO. 458
Riee Gasoline Rock Drill Co..... 262
Richardson-Phenix Co. 586, 710

Page

Rivetless Chain and Engineering Co..... 643
Roebling Son's Co., John A.....64, 458
Roessler & Hasslacher Chemical Co..... 130

SACKETT MINE SUPPLY CO..... 394
Samson Mfg. Co. 196
Scranton Pump Co. 643
Simonds & Co., G. L. 328
Smith Co., T. L. 130
Star Mfg. Co. 328
Stine Co., J. C.....586, 643
Sullivan Machinery Co., 64, 130, 196, 262, 394, 586
Sylvester Co. 262

UNION ELECTRIC CO. 262

WAGNER ELECTRIC MFG. CO..... 643
Warwood Tool Co. 196
Waterhouse Welding Co..... 643
Wheeling Mold and Fdy. Co..... 196
Williams Patent Crusher and Pulverizer Co. 64
Wing Co., L. J. 780
Wolf Safety Lamp Co. of America.....522, 710
Worthington, Henry R. 64

Index E—Trade Notices

ALDRICH PUMP CO. 716
Alexander Car Replacer Co..... 716
American Blower Co.....262, 394, 522
American Mine Door Co..... 457
American Safety Lamp and Mine Supply Co. 780
Armstrong Cork Co.....129, 457, 522

BALDWIN-WESTINGHOUSE CO. 64
Belmont Coal Mining Co. 195
Bristol Co., The 328
Brownell Co. 64
Buffalo Foundry and Machine Co..... 716
Bury Compressor Co. 328

CAMERON STEAM PUMP WORKS, A. S.....64, 328, 586, 649
Christy Box Car Loader Co..... 129
Concordia Safety Lamp Co..... 586
Crawford & McCrimmon Co.....64, 650

DE LAVAL STEAM TURBINE CO..... 521
Dewat Mfg. Co. 650
Dixon Crucible Co., Jos..... 195
Du Pont Powder Co., E. I..... 780

EASTON CAR AND CONSTRUCTION CO. 328
Electric Railway Equipment Co..... 129
Electric Storage Battery Co..... 779

Page

FAIRMONT MINING MACHINERY CO 130, 716

GENERAL ELECTRIC CO. 129, 194, 328, 522, 650, 716
Goulds Mfg. Co. 64, 328

HAZARD MFG. CO. 650
Hirsch Electric Mine Lamp Co..... 128

INGERSOLL-RAND CO.....586, 650, 716

JOHNS-MANVILLE CO., 128, 261, 327, 394, 779

KOLESCH & CO. 130

LESCHEN & SONS ROPE CO., A..... 394
Lidgerwood Mfg. Co..... 650
Link-Belt Co.....64, 129, 195, 457, 521, 650
Lufkin Rule Co..... 779
Lunkenheimer Co. 63, 458

MANIERRE ENGINEERING AND MACHINERY CO. 458
Marion Steam Shovel Co. 522
McLain Co., W. R. 262
Mt. Carmel Iron Works 716

NATIONAL TUBE CO.....118, 130, 458, 716
Nelson Valve Co. 457
Nicholson, Col. W. H. 716

OHIO BRASS CO. 195
Ottumwa Box Car Loader Co..... 129
Ottumwa Iron Works 780

ROBERTS & SCHAEFER CO. 64, 129, 196, 261, 521, 716, 779
Robinson Ventilating Co. 522
Roessler & Hasslacher 195

STINE CO., J. C. 586
Stonehouse Enameled Steel Sign Co... 195
Sturtevant Co., B. F.....129, 394
Sullivan Machinery Co. 394

TROPICAL OIL CO. 195

VAUGHN, L. D. 522, 650

WEBSTER MFG. CO. 128, 650
Western Electric Co. 128, 650
Wiener Co., Ernst 328
Williams Patent Crusher and Pulverizer Co. 458
Wolf Safety Lamp Co. of America, Inc..... 393

The Colliery Engineer

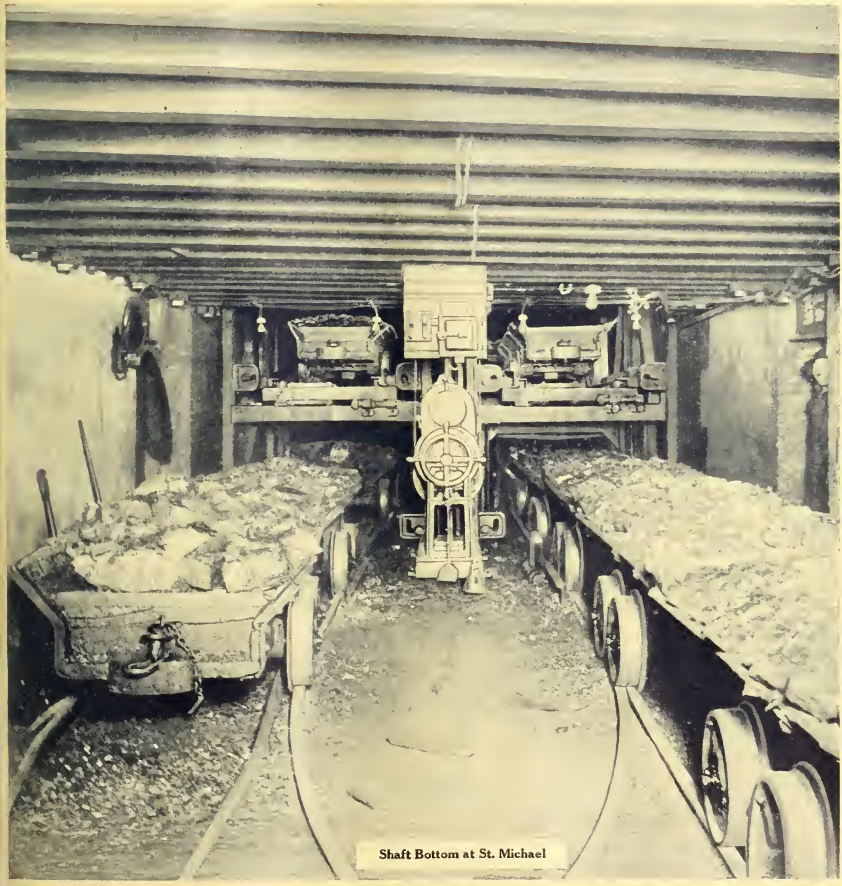
Formerly Mines and Minerals

LIBRARY
AUG 5 1913
UNIVERSITY OF TORONTO

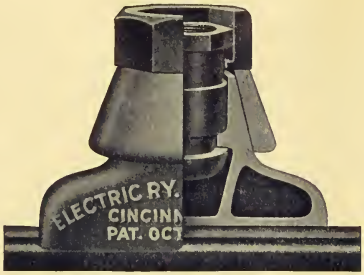
. XXXIV—No. 1 AUGUST, 1913 Scranton, Pa.

abetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68



Shaft Bottom at St. Michael



"SURE GRIP"

"Sure Grip" is not simply a trade name used to designate our particular brand of Trolley Clamps. It is also an absolute guarantee—it's a fact.

The "Sure Grip" Trolley Clamp is all its name implies.

It is so constructed that, once adjusted properly, it is simply impossible for it to work loose or to drop the wire.

This is but one of the features that has made the "Sure Grip" Trolley Clamps so popular in the mine field. Men in the workings feel absolutely secure when walking along passages where trolley wire is strung. They know that the wire **cannot** work loose and hang down, endangering their lives.

Made in all sizes from 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine and Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 90 West St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah (Office Atlanta) Cleveland
San Francisco Los Angeles
Seattle Portland, Ore.

HAZARD WIRE ROPE

FOR EVERY PURPOSE

HAZARD MFG. CO.

WILKES-BARRE, PA.

NEW YORK. PITTSBURG. CHICAGO.

COPYRIGHT, 1913, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXIV No. 1 AUGUST, 1913 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1881

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second-class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

CIRCULATION THIS NUMBER 12,700

TABLE OF CONTENTS

Editorial—
Notes—"Near Doomed Cities"—Acetylene Lamps in Coal Mines—Reference Books at Examinations—Pyrite in Coal—Coal Competition—New Mining Law in Missouri ... 1
Personals ... 4
Four-Decked Cage at St. Michael ... 5
Prevention of Coal-Dust Explosions ... 10
The Coal Fields of Western Canada, by Arthur Lakes ... 11
Testing for Carbon Monoxide ... 14
Lake Superior Mining Institute ... 15
Hogan on the Taxation of Anthracite ... 15
National Conservation Exposition ... 16
Mine Fires ... 16
Coal Mines Under the Sea ... 17
Working an Inclined Coal Bed, by Geo. Watkin Evans ... 18
The American Mining Congress ... 21
Kentucky First-Aid Team Meet ... 22
Efficiency Valuation of Fuels, by W. F. Elwood ... 23
Closing Exercises of the Lehigh Valley Schools ... 25
The Coal Mining Institute of America ... 26
Rescue Work at British Mines ... 27
Fire Protection of Mines, by James Taylor ... 28
Dustless Breakers ... 29
Steel in Mine Construction, by Carl Scholz ... 30
The Stewart Broken Back Splin, by W. Bert Lloyd ... 32
Examinations—
Mine Inspectors', Pottsville, Pa., May, 1913 ... 33
American Peat Society ... 37
Letter Box—
Carbon Monoxide Not a Supporter of Combustion—Dump Car Wanted—Is Carbon Monoxide a Supporter of Combustion?—Location of Regulator ... 38
Book Review ... 39
Obituary—
Baird Synder, Jr.—Charles S. Shindel ... 40
Should Exhaust Steam Be Wasted, by P. Barrett Coulston ... 41
Practical Talks on Coal Mining—
Mechanics of Mining, 43—Mine Ventilation, 45—Electricity in Mines ... 47
Acetylene Lamps in Coal Mines ... 49
The Preparation of Coal, by Gordon Buchanan ... 51
United States Coke Production, 1912 ... 52
Schaefer Method of Resuscitation ... 53
Double Explosion of Dynamite ... 54
Notes on Mines and Mining ... 55
West Virginia Mining Institute Meeting ... 56
Prize Contest ... 58
New Mining Machinery—
Connecting Steam Turbines for Operating on Exhaust Steam, 60—Mine Recovery Telephone Equipment, 62—Approved Electric Mine Lamp, 63—The Proto-Fleuss-Davis Apparatus ... 63
Trade Notices ... 63
Catalogs Received ... 64
Squibs—
Briquetts in France, 27—Virginia Coal Production, 32—Lignite Briquetts in Germany, 51—New Mexico School of Mines, 54—Fusion of Fire and Silica Brick ... 59

WHAT'S the use of a fire boss struggling with the fifth root and equivalent orifices?" This question was asked the editor the other day. There is no use of his learning anything about either if he wants to remain a fire boss.

EVERY subordinate mine official has specified work to perform. Those who do their "stunt" well hold their jobs. Those who do their "stunt" well and a little more, eventually become managers.

IN THE first 6 months of this year the metal mines of this country are credited with over $62,000,000 in dividends, which causes one writer to remark that while the value of the coal mined in 1913 will be over $626,000,000 the dividends will be less than for the metal mines the first 6 months of the year.

THE July issue of a so-called technical magazine, published in Chicago, contained an illustrated article entitled: "Near-Doomed Cities," written by an editor of our trade contemporary, *The Black Diamond*. The article in question contained so much that was ridiculous, sensational, and false, regarding the danger to life and property in Scranton, Wilkes-Barre, Pittsburg, and other Pennsylvania cities and towns, Fairmont, W. Va., and Springfield, Ill., that we have had numerous inquiries as to what cause impelled an editor of a coal-trade publication to make such statements.

We might surmise that the author of "Near-Doomed Cities" was subject to brain storm due to a tomahawk blow on the head during a raid of Sioux Indians on Chicago a month or two ago, if we were as ignorant of conditions in the Middle West as he seems to be regarding conditions in various coal fields. The lack of knowledge displayed regarding coal geology and methods of working, the misquotations from the report of Messrs. Griffith and Conner, geologist and mining engineer, and the prediction, through pictorial inference, of a duplication of the Monongah disaster at Scranton, showing marked ignorance as to the difference in composition of Pennsylvania anthracite and Fairmont bituminous coals, is such as to make possible the explanation—"he doesn't know any better."

COPYRIGHT, 1913, BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

Acetylene Lamps in Coal Mines

THE acetylene lamp is not only a safe illuminant for mines in which open lights can be used, but it has less deleterious effect on the mine atmosphere than the ordinary open light. This may seem a strong statement, but it is proved by the results of tests made in our own laboratory, which have been corroborated by tests made by Mr. Edwin M. Chance, Consulting Chemist, of Wilkes-Barre, Pa., who arrived at the same conclusions by a different method. Our tests were made in the interest of our readers. Neither Mr. Chance, nor any manufacturer of carbide lamps knew of them. As a coincidence, the manufacturers of the Baldwin lamp employed Mr. Chance, as a chemist conversant with coal mining conditions, to make a thorough test for them, and we have had access to the general results obtained by him. A detailed description of our tests with results will be found on another page.

Reference Books at Examinations

THE question, whether candidates for state examinations for mine foremanships, inspectorships, etc., should have access to reference books or not, is one that is not open for much argument.

A well-educated man is not one who has perfect knowledge of everything he studied stored up in his mind. He is the man who possesses a *general* knowledge of a subject, and who knows where to quickly find, and how to apply specific information. Men who can remember *all* the details and formulas pertaining to complex technical subjects are not practical men. They are "freaks."

Successful men realize that it is impossible for the human mind to remember for any considerable time all the formulas and rules relating to various subjects connected with the details of coal mining, and they do not try to remember them. But, they know where to find the rules and formulas, how to modify them, if necessary, to suit conditions, and how to apply them. They have their reference books in convenient places and they use them.

In mining examinations, there should be a time limit set, in which each question involving the use of formulas should be answered, and the candidates should be allowed access to reference books. The readiness with which they find the rules and formulas, and correctly apply them, should determine their relative fitness for certificates.

Pyrite in Coal

THE late Professor Lord stated that "the action of pyrite mixed with coal is not clearly understood by some, and that rather than being a drawback, like ash, it added its quota of heat units to those of the carbon."

This is mentioned for the reason that good coal containing pyrite has been generally condemned, on the ground that it caused slagging or clinkering in the firebox of the boiler. There are many practical examples to show that the slagging is not due to pyrite, but to the fusing together of basic oxides with silica. The iron in pyrite cannot enter into a combination with silica and other basic oxides until it is converted into ferrous oxide after this sulphur is oxidized. This is no easy operation, and requires an oxidizing roasting furnace with plenty of air and time. The contention is that the boiler furnace is not an oxidizing roasting furnace for pyrite, since it scarcely affords sufficient oxygen for the complete combustion of the carbon in the coal and if more than 12 pounds of air per pound of carbon is supplied there will be a waste in heat units.

This practically eliminates the oxidation of pyrite to ferrous oxide, in all but low-ash coals, and those whose sulphur is insufficient to satisfy the chemical reactions that take place. What the conditions are that favor slagging can be foretold from an exhaustive analysis of the coal, and the application of Balling's factors. "Valentine has shown that when pyrite is heated one hour at 1,832° F. in the absence of air, it gives up only 26.27 per cent. of its sulphur, and only 44 per cent. when at the extremely high temperature of 2,599° F. (white heat) which would appear in a furnace fire, consequently the desulphurization of pyrite will be slow," and at that heat it will be converted into ferrous sulphide. Since we advocated the use of Balling's factors in connection with an exhaustive analysis of coal, the principle involved has been tried and proved satisfactory to a man who purchases over $1,000,000 worth of coal annually, and he seems to be able to determine from his figures whether a coal will slag or not under the boiler. One of the recent and valuable additions to the literature on coal burning is entitled "Efficiency Valuation of Fuels," by W. F. Elwood, chemist for the Keystone Coal and Coke Co., and it is given in another column.

Coal Competition

SO MUCH coal is found in the Appalachian and Middle coal fields of the United States that it has been, and for several generations will continue to be, an impossibility for any combination of interests to control the production.

Apparently not realizing this condition, operators in the same field have been competing in their natural or home markets to see who could sell the most coal for the least money, and in addition have tried to compete with others from distant fields who have better coal, at least for some purposes.

In coal mining, "the survival of the fittest" will continue to apply, even if the useless scramble to sell coal cheap continues, for the basic factors which enter into competition, being natural, will prevail, although it may be possible for artificial conditions to be in the ascendent temporarily.

In any coal field the natural market is the one nearest home; and that being supplied, the surplus product is shipped where it must compete with coal from other fields.

The coal sold in the home market should, and naturally does, command a higher price than in more distant markets where it must compete with other kinds of coal. When a coal is unable to compete with foreign coals in its home market, it is inferior in quality, costs too much to produce, or is not sufficient in quantity to supply the demand; and if any one of these three factors prevails, the true essence of competition does not exist.

The fierce commercial warfare going on in the Pittsburg district among home producers to sell coal is not competition, it is overproduction for the home market; and the only remedy is to go into foreign markets and sell at a profit.

Martin Bolt, Chief Clerk of the State Mining Bureau of Illinois, states: "The large producing mines of Illinois are getting most of the business, and the indications are that soon the smaller mines will be a thing of the past."

In Illinois, if any competition exists, it is among Illinois operators for the home market. As an illustration, Franklin County coal is selling in St. Louis for $1.92 per ton, or for $1.25 at the mines. It costs f. o. b. at the tipple 94 cents per ton. West Virginia coal is selling for $3.90 in the same town or for $1.40 at the tipple. If there is any competition in these transactions it must be among the operators of Illinois. In Detroit at this writing Pittsburg gas coal is selling for 25 cents less than West Virginia gas coal, although both sell for the same price at the mines. There does not appear to be any competition here, for West Virginia gas coal could not find a market at 25 cents per ton more unless it was a better coal for the consumer; at any rate the West Virginia operators are not selling below the cost of production.

In New York, Pocahontas and New River coal comes in competition with Cambria, Somerset, Indiana, and Clearfield counties Pennsylvania coal.

The best Miller bed coal is selling for $1.60 at the tipple and for $3.20 in New York, while the West Virginia coal sells for $1.10 at the tipple and $3 in New York.

This is real competition, yet none of the West Virginia operators are losing money, as can be surmised from the prices asked at the tipple. It has been claimed that a conspiracy exists between the operators of Western Pennsylvania, Ohio, Indiana, and Illinois and the United Mine Workers to unionize West Virginia in the hope of making the cost of production so great the competition cannot exist. As we have demonstrated, West Virginia coal has no competition in the West, and what competition exists in the East is on smokeless coal, which the states mentioned do not mine, consequently if such a conspiracy did exist it would not hurt West Virginia, nor would it benefit the conspirators, since it is an impossibility for any combination of interests to control the coal production in this country.

New Mining Law in Missouri

THE new law enacted by the late legislature for the working in coal mines in Missouri, provides that state inspectors shall post a notice in a conspicuous place at each mine, giving the actual condition of the entire shaft, with recommendations of what improvements, in the opinion of the inspectors are necessary, to safeguard the lives and health of the workmen.

Another notice must be posted at the landing used by the miners stating the number of men that can safely be lowered or hoisted by the car or cage. If the inspectors find that a mine is unsafe for any reason, they can require the operator to make the necessary alterations to place it in a safe condition, or, may have the mine shut down on application to a circuit court.

In line with these safety requirements to decrease the chances of injury, the law makes the fellow-servant act applicable to mines the same as to railroads. Under this provision the mine operator is liable to the employe for injuries or death which may result by reason of the negligence of a fellow employe.

Under this fellow-servant law, the maximum damages for the death of an employe recoverable by the relatives is placed at $10,000. Suit on death claims may be filed at any time within 6 months after the death of the employe.

The doctrine of contributory negligence is retained in the new law, permitting the operator to set up in defense against a death or injury claim that the employe contributed to his injuries by his own carelessness.

The Missouri law provides for the appointment of five inspectors and a chief mine inspector. Two of these inspect coal mines and the others devote their attention to lead and zinc mines. Each inspector is required to have had 5 years' practical experience in lead and zinc mining. He receives a salary of $1,800 a year and expenses while traveling.

The mine operator who employs more than 25 men is required to have an experienced person examine the hoists twice each week to ascertain their safety. They are required at intervals of 6 months to have all boilers examined and tested by hydrostatic pressure and warm water. The result of the test must be certified to the mine inspector.

The inspectors closed 9 mines in 1911, and in 10 others required a special man to look after the roofs; they ordered 15 powder magazines built and in 18 shafts new timbers were ordered. The foreword in the last report says:

"The mine inspection department is no longer one of minor importance. It has to do with an industry which is largely a gamble with death, and the state cannot afford to deal lightly with a proposition upon which depends the health and safety of so many of its citizens."

PERSONALS

The Examining Board for State Mine Inspector of the Nineteenth Anthracite District of Pennsylvania concluded the marking of the examination papers, at Pottsville, on the 7th ult. There were nine applicants. M. J. Brennan, present Inspector of the Nineteenth District, was the only one that succeeded in securing the necessary percentage entitling him to a certificate.

William P. Hawkins has been appointed Fuel Agent of the Missouri Pacific-Iron Mountain System, to succeed W. J. Jenkins, resigned.

E. P. McOlvin has resigned as superintendent of the Rich Mountain Coal Co. to accept a similar position with the Marion Gas Coal Co., with headquarters at Enterprise, W. Va.

George Sylvester, Chief Mine Inspector of Tennessee, has appointed as deputy mine inspectors for a 2-year term, Messrs. W. A. Overall, H. H. Braden, and John Rose.

L. Blenkinsopp has been appointed District Mine Inspector for the Eleventh West Virginia district, with headquarters at Welch, W. Va.

E. H. Coxe has been appointed general manager for the La Follette Coal and Iron Co., of La Follette, Tenn.

W. H. MacEwan has been elected assistant secretary of the Philadelphia & Reading Coal and Iron Co. Mr. MacEwen has been with the company 22 years, a considerable part of the time as chief clerk to Secretary Brown.

James Dalrymple, Chief Coal Mine Inspector of Colorado, has been reappointed by the Governor.

T. A. Freese, State Mine Inspector, Huntington, Ark., has resigned to become commissioner for the Southwestern Coal Operators' Association, embracing Missouri, Arkansas, Kansas, and Oklahoma.

John W. Boileau, Geologist, of Pittsburg, delivered an address before the Coal Mining Institute of America on the "Geology of the Pittsburg Coal Beds."

S. O. Andros, Secretary, Coal Mining Investigations, of Illinois, is traveling in Europe investigating foreign conditions of coal mining.

John T. Morris, formerly Assistant Chief Engineer of the T. C. I. & R. R. Co., at Birmingham, Ala., has been appointed Superintendent of the Weyanoke Coal and Coke Co., Lowe, W. Va.

Leroy A. Palmer, well known to the readers of The Colliery Engineer, has changed his address from the United States Forest Service in Denver, Colo., to United States General Land Office, 46 Federal Building, Helena, Mont.

H. H. Stoek, Professor of Mining Engineering, University of Illinois, attended the meeting of the Coal Mining Institute of America, held in Pittsburg, June 17.

R. M. Frey, of Uniontown, Pa., has accepted the position of general manager of the Orient Coal and Coke Co., to succeed the late O. W. Kennedy.

W. G. Grove, formerly of the United States Bureau of Mines, has been appointed chief of the first-aid organization of the Berwind-White Coal Co., at Windber, Pa.

Prof. L. E. Young, Director of the School of Mines, Rolla, Mo., has resigned, owing to politicians making use of the school's prestige for political purposes, D. C. Jackling, vice-president of the Utah Copper Co., and John A. Garcia, of the firm of Allen & Garcia, both alumni of this institution and others, had objected to H. H. Hohenshield, a former State Senator, being selected as architect for the $70,000 gymnasium building. The political factions which have existed in Rolla for many years have been a cause of much disappointment to the various mining professors, who have been in charge at that college.

J. F. Healy, who has had 10 years' experience as manager of coal operations, and 5 years' experience as to railroad location, construction, and maintenance, has opened an office as consulting mining engineer, Room 1201, Union Building, Charleston, W. Va.

The Southwestern Coal Operators' Association at their meeting held recently in Kansas City, Mo., elected C. C. Woodson, of Huntingdon, Ark., as vice-president.

E. R. Sweeney, manager of mines for the Central Coal and Coke Co., of Kansas City, Mo., has resigned.

W. L. Schmick, vice-president and general manager of the Consolidated Coal Co., of St. Louis, has resigned that position to accept a similar one with the Big Muddy Creek Coal and Iron Co., with headquarters at St. Louis, Mo.

W. J. Jenkins has been appointed to succeed W. L. Schmick as vice-president and general manager of the Consolidated Coal Co., of St. Louis, in addition to his present duties as vice-president and general manager of the Western Coal and Mining Co.

C. H. Thompson, coal operator and mining engineer of Knoxville, Tenn., who is also president of the Meyers Whaley Mfg. Co., manufacturers of coal shoveling machines, was in Johnstown recently in the interest of his machine.

Announcement has been made from the office of the Clearfield Bituminous Coal Corporation, New York, that Rembrandt Peale, the well-known coal operator, succeeds the late R. A. Shillingford on the board of directors of that corporation. H. B. Douglass, formerly coal inspector for the New York Central lines, and at one time manager of the Vinton Colliery Co. operation at Vintondale, has been appointed general manager of the company's operations with headquarters at Clearfield, Pa. His assistant will be H. J. Hinterleitner, who was for many years assistant to Mr. Shillingford.

C. P. Collins, who has been engaged for the past 2 years by the Berwind-White Coal Mining Co., in expert sanitary and waterworks engineering, has completed that work and expects to open an office in Johnstown, specializing on sanitary and water supply engineering.

COAL MINING & PREPARATION

Four-Decked Cage at St. Michael

A New Method of Hoisting Coal, Which Admits of Rapid Handling of the Cars and Gives Large Capacity to the Shaft

Written for The Colliery Engineer

ON MAY 31, 1889, an artificial lake burst the dam which confined it and caused the Johnstown, Pa., flood. On the site of this former lake a new mining town called St. Michael has been laid out in streets, on both sides of which double frame houses, neatly painted, face each other. This town, which is on a large, comparatively level tract of land, could be developed, so far as space is concerned, into a good-sized city.

On one border of this lake bed some distance from the houses is a timber tract forming groves; through the center of this lake bed flows a stream of clear water; distant about one-half mile from the houses and beyond this stream is the railroad.

St. Michael, which is so favorably situated, is supplied with waterworks, electric lights, churches, a two-story-and-basement, brick, public-school building, and such other advantages and amusements as to make the men and their wives contented with their surroundings. Each house has a front yard and a long back yard, in which, if the tenants desire, they can raise a large part of the vegetables they consume during a year.

These properties are known as the Maryland Coal Co.'s, of Penna., which has constructed substantial brick company buildings that, with the houses and other structures, give the town an appearance of prosperity which the citizens appreciate.

The St. Michael mine was started by a concern that either did not anticipate or failed to realize the difficulties likely to arise in working some shaft mines. When the original capitalization proved insufficient to carry on the work, the Berwind-White Coal Co. took charge, and under the supervision of the latter company's general superintendent, W. R. Calverley, the plant was completed. One of the difficulties encountered was an underground stream of water that was tapped at a depth of 270 feet from the surface. This water interfered with sinking operations and caused a great deal of extra expense. When the new management took over the property they built a catchment basin under this water-carrying stratum and connected the two shafts at this point by a rock tunnel, and pumped the water to the surface. The water being pure and cool is now pumped to a reservoir on a hill nearby, from which it flows by gravity to the houses in the town and forms the supply used for domestic or for fire purposes.

As shown in Fig. 1, there are two shafts at St. Michael, each 706 feet deep. One is used as a hoisting

FIG. 1. SURFACE PLANT AT ST. MICHAEL, PA.

shaft, and the one back of the power house is used as a man hoist and auxiliary shaft. The coal is mined from the Miller "B" or the lower Kittanning bed of the Lower

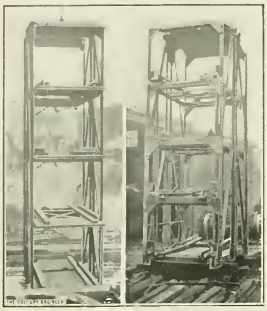


Fig. 2. Cager and Cage

Productive coal measures of Pennsylvania. The coal from this bed has been mined by the Berwind-White Co. continuously for many years in one place or another, and it was from shipping this excellent coal that the company has obtained such an enviable reputation in the coal trade.

While the shaft cuts the Middle and Upper Kittanning, and Upper and Lower Freeport beds, the latter known as E and D beds, respectively, there has been no attempt made to mine them, because it is desired to keep to the company's standard coal. The Miller "B" bed is here 42 inches thick, consequently the mine car used is necessarily small. It holds 1,900 pounds of coal, therefore to obtain an output of from 2,400 to 3,000 tons of coal per day it requires that from 2,280 to 3,420 cars be hoisted in one shift of 8 hours. This rate of hoisting means from 285 to 440 cars per hour, or, if allowance is made for stops, from 6 to 9 cars per minute. There is considerable danger from accidents when hoisting at this speed; besides, it must necessarily follow that there will be excessive wear on the machinery and other movable parts, when so many hoists must be made during a shift.

About 2 years ago W. R. Calverley investigated the various hoisting plants in Belgium, England, and Germany, for the purpose of ascertaining the foreign practice of hoisting. In Europe, two-, three-, and four-deck cages are operated in balance; each deck carries two small cars. At the Cadby colliery in England the cages have the cars pushed on and pushed off by hydraulic machinery, auxiliary cages being used for the purpose both at the top and bottom of the shaft. It is claimed that by this arrangement labor is minimized; time is saved, owing to the caging and landing taking place with regularity, with precision, and without haste, thus lessening the possibility of accidents to the men. This method of caging and landing produces efficiency and safety, the two items which count most at a busy coal mine. The investigations abroad convinced Mr. Calverley that he should make use of the multiple-cage system with modifications, as the conditions which prevailed at the St. Michael mine made it unnecessary to use the auxiliary cages at the surface. After consultation with Mr. Frank Green, who devised the Green dumper, it was decided to make use of two four-deck cages, with auxiliary cagers at the bottom and a four-stage dumping platform at the top of the shaft.

men to direct the cars to the dumpers and load them on the dumpers, and after they are dumped send them to the landing and load them on the cage. By making use of dumping platforms it was thought that considerable labor could be saved, as well as time, for the cars in use could be returned directly from the dumping platforms to the cage without manual switchbacks, etc., and taken into the mine on the same cage which brought them to the surface.

The St. Michael plant is considered an innovation in American hoisting practice, and so far as known also differs materially from anything abroad. The hoisting cages, 22 feet high, 8 feet 4 inches long, 5 feet 9 inches wide, built of steel, are shown in Fig. 2 as assembled before shipping. This illustration is from a photograph taken before the shaft was ready for the cages. The auxiliary shaft shown in Fig. 1 to the rear of the power plant was used for hoisting coal, men, rock, and for lowering materials, while the main shaft was being completed. At present this shaft is used for rock, men, and materials, while the coal is hoisted through the main shaft shown to the left of the power house. At the top of the head-frame of the auxiliary shaft will be seen a steel crane with a crawl. There is a similar one above the main shaft head-frame, which Mr. Calverley had installed, the

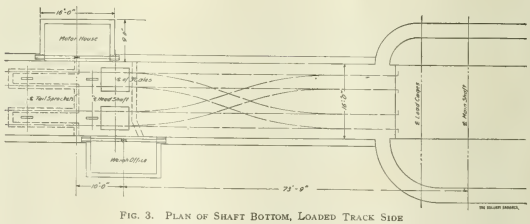


Fig. 3. Plan of Shaft Bottom, Loaded Track Side

In Europe it is customary to run the loaded cars from the cage landing some distance to dumpers, then back switch them to the cages. This arrangement requires a number of object of which is to lift, remove, and lower to the ground the sheave wheels that are worn or broken and replace them with new wheels. Without some such arrangement, it

takes a day to do what can be accomplished with this crane and crawl in about 2 hours. A fairly good idea of the auxiliary load cager and the hoisting cage can be had from Fig. 2.

The auxiliary load cager, which hereafter will be termed "cager," is shown on the left, and the hoisting cage, which will hereafter be termed "the cage," is shown on the right. The "empty cagers" used at the bottom of the shaft do not differ materially in looks from the cager in Fig. 2, although they have different details. The conditions to which this plant conforms are about as follows: Hoisting must be done in balance; four cars must be caged and four empties landed at the same time at the bottom of the shaft; four cars must be dumped at once and placed on the cage empty in so short a time that there will be no hindrance to the movement of the loaded cage at the bottom. This plan involves a larger number of details, including special dumpers, pans, special chutes, and machinery. The arrangements at the shaft bottom are more complicated than those at the top, because only one car can be loaded on the cager deck at a time, and only one empty car can be released at a time from the empty cager deck, and because these operations must be completed by the time the cage has made a round trip to the surface and back. The shaft bottom at St. Michael mine is supported by iron beams and concrete, also the run-around is supported by concrete, and as the shaft bottom is lighted by electric light, and whitewashed, the men can see a long distance and follow the progress of the cars.

Fig. 3 shows a plan of the shaft bottom on the loaded track side, with the weighing scales and double cross-overs.

Fig. 4 shows an elevation and plan of the shaft bottom, with the arrangements for the cagers which are not detailed in Fig. 3.

The cages and empty cagers work in pairs, the ends being in line with the ends of the cages. The cagers are operated by electric power, the operator standing a short distance back from them, between the two, where he can watch the

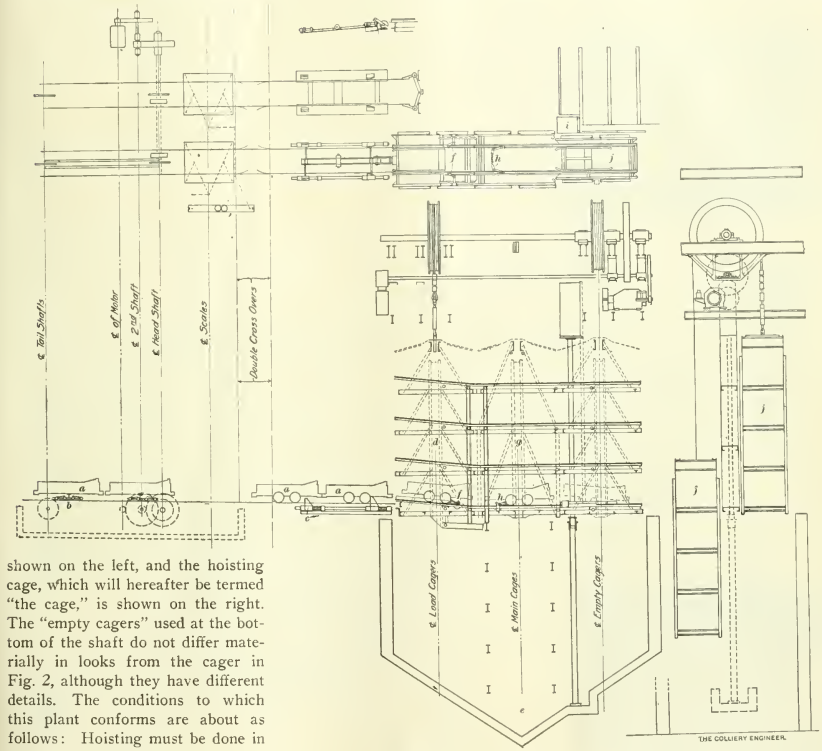


Fig. 4. Plan and Elevation of Caging Apparatus

mine cars being caged. The loaded trips are delivered above the scales by electric locomotives; the mine cars *a* are placed on the scales by the chain haul *b*, after which they run by gravity over the proper track to the car stop *c*, which is in place by the stops *f*, shown also in Fig. 2. The cager is then lowered one deck and another car is loaded on the second deck, then the third, and lastly the top deck is loaded, by which time the cager is down in the sump and the opposite they are stopped and held in position by the spring stops and buffers *h*. When these cars are in position on the cage, the back end of the car is lower than the front end, so that the car door may be unlatched and the coal not spill out. This is

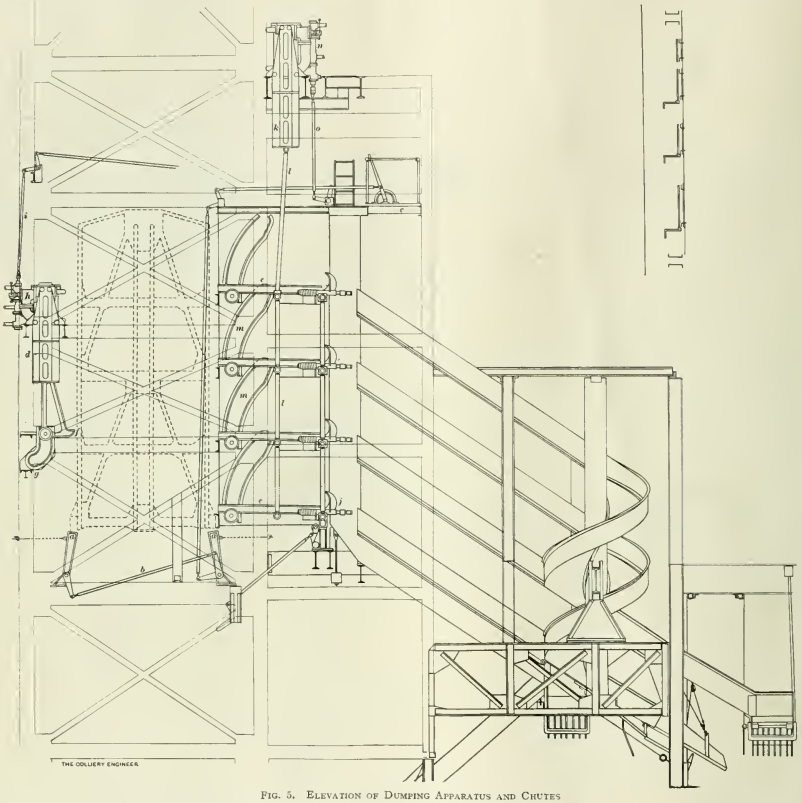
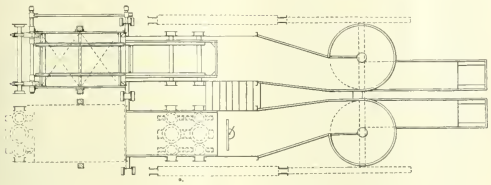


Fig. 5. Elevation of Dumping Apparatus and Chutes

worked by the operator doing the caging. Cagers *d* are loaded downwards alternately, so that the loaded cager rises from the sump *e* as the other cager is being loaded and going down into the sump. When the car stop *c* is opened the loaded car runs on the cager and is held cager is ready to be discharged to its respective cage *g*.

When the cage is in position to receive loaded cars, the cager platforms are tilted at an agle of about 60 degrees, which starts all the loaded cars running on to the cage platforms at the same time where necessary because of the dumping arrangements at the top being such that the cars could not be unlatched without loss of time. The man who unlatches the cars is the operator, and he rides up and down in the cab *i*, from which he oversees the caging, the discharge of the emp-

ties, and that the car latches are lifted before the cage is hoisted. One of the empty cagers *j*, shown in Fig. 4, is in position to receive the empty cars coming from the cage, the other is in position to have the



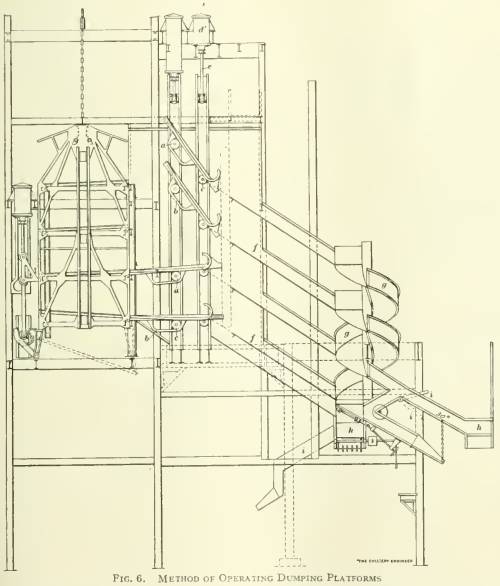


Fig. 6. Method of Operating Dumping Platforms

last car on its top deck removed. The other empty cager is being unloaded one car at a time, and is moving downward into the sump so that by the time it is unloaded the first empty cager is in position to receive the empties coming from the cage. When the cages reach the landing, the "keeps" *a* shown in Fig. 5 are moved under the cage by the lever *b*, manipulated by the operator or lander on the platform *c*. After the cage settles and comes to rest on the "keeps," the cylinder *d* is put in operation and lifts the platforms on the cage to an angle of from 4 to 6 degrees, which starts all of the cars moving simultaneously to the dumping platforms *e*. The horn *f* connected with the cylinder *d* is in normal position when it is at *g*, and when at *f* it is in the position it occupies after tilting the platform of the cage. Valve *h*, which operates this cylinder, has a working lever *i* connecting the platform *c*. After the cars have reached the horns *j* on the dumping platform, the cylinder *k*

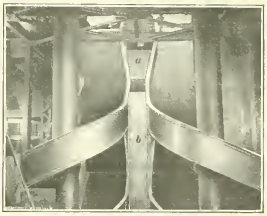


Fig. 7. Spiral Chute

tilts the platform by means of rods *l*, to an angle of 50 degrees, and at same time swings the loaded platforms forward towards the chutes. To keep the cars from going into the chutes there are guards *m* in which the flanges of the hind wheels of the cars run as the platform tips.

The valve *n* which operates cylinder *k* is manipulated by the lever *o* from platform *c*. As the reach rod *l* is raised, a long rod from cylinder *d*, Fig. 5, lowers the front end of the dumping platform. When the dumping platform is being raised in

Fig. 8. Loading Spouts

the rear and lowered in the front, the rollers *a* underneath the platform work in brackets *b* and assume the positions of the two upper platforms shown in Fig. 6.

The forward movement of the platforms is facilitated by means of

the rollers *c*, fastened to the cylinder *d* by means of rods *e*, and cross-arms not shown. This places the front of the cars where they can discharge their contents into the pans *f*, connected with spiral chutes *g* that terminate in the loading spouts *h*. There being two hoisting cages, it is advisable to use two sets of spiral chutes which discharge the load into the two cars or, if desired, into the same car.

Fig. 7 shows the spiral chutes with a place *a* where rock picking is carried on, and the rock chute *b*, also shown at *i* in Fig. 6. The loading spouts *a* and the aprons *b* are arranged so as to load the cars in the center, as shown in Figs. 6 and 8. Gates are arranged in each chute so as to provide for the proper inspection of each car of coal separately. This radical departure from American hoisting practice even where the coal bed is high and the mine cars large will undoubtedly lead to further improvements that will increase the daily output, lessen the cost of labor, and provide safety devices to protect the men who must work at the bottom and top of shafts. The writer is indebted to the C. O. Bartlett & Snow Co., of Cleveland, Ohio, for supplying the illustrations for this article.

Prevention of Coal-Dust Explosions

Written for The Colliery Engineer

Recently, attention has been directed to the experiments being made to stop coal-dust explosions after they have once started.

The precursive wave or air pressure preceding the flame of an explosion lifts fine coal dust from the floor and dislodges that which has accumulated on the walls of entries, thus adding fuel to the fire and increasing the intensity of the explosion. Unless, therefore, some means is devised to extinguish the flame following the precursive wave, the explosion cannot be stopped with certainty.

Up to the present time the chief preventive devices have been sprinkling stone dust on the roadways and coating the walls with stone dust; sprinkling water on roadways and wetting the walls of working places; hanging Tafnel dust shelves,

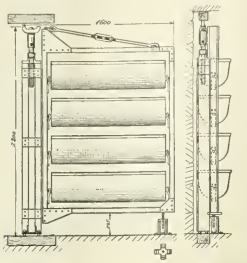


Fig. 1

and using shelves on which easily upset water troughs have been placed.

In one method that has been tried the mine is divided into zones that are treated with stone dust, with the object of dividing the roads and workings into sections over which the flame will not pass owing to non-inflammability of the stone dust, which mixes with whatever coal particles are in the air.

A somewhat similar system has also been tried in the French State gallery at Lievin, and in the trial gallery at Derne, belonging to the Westphalian Mining Co., while at the Rossitz Austrian trial gallery an experiment was carried out at the request of the permanent Viennese Committee for the investigation of matters relating to firedamp. The water explosion extinguisher shown in Fig. 1 is called the "zone apparatus" in Dortmund-Korne, Germany. It consists of a massive frame which is fixed to the walls of

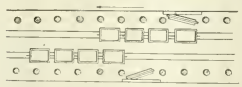


Fig. 2

the gallery, and a second but lighter frame which is suspended from the former by means of hinges and projects similarly to a door. It carries a number of light vessels which will be overturned and their contents spilt along the gallery when the light frame is opened. This frame is left in a half-open position on the side from which the explosion may proceed, so that it will open completely by the action of the precursive wave. Obviously, the violence of the explosion will upset the vessels and discharge their contents over a certain distance into the cloud of dust which always precedes the flame.

In this way, the dust is saturated and cooled. The contents of the vessels may be of a special fire extinguishing nature, and a special fluid called "Hermanit" is used, which possesses fire extinguishing properties, while its non-evaporative character removes one of the drawbacks connected with the use of water. One such apparatus is quite sufficient for single tracks, while where double tracks are used, two appliances are fixed on opposite sides of the roadway, as shown in Fig. 2 in which the arrow points toward the shaft.

It will be evident that the apparatus in no way interferes with the hauling or with the ventilation of the mine, and it is only when the air pressure originating at the place of ignition and preceding the flame catches the rear surface of the protruding door-like apparatus that it is revolved on its axis, tips over the containers and dashes their contents far into the gallery. Protective devices are fitted to the apparatus to prevent unauthorized interference, while there is an inspecting device for the mining official who has charge of the apparatus, and who is responsible for seeing that it is always in proper condition for operation.

Each apparatus contains about 110 gallons of quenching fluid, and it will therefore be seen that by subdividing the mine galleries into a system of zones, and equipping them with this extinguisher, a very effective prevention of explosion due to volatile components in the mine air, is formed.—*J. E. S.*

The Coal Fields of Western Canada

Where They Are Situated, Their Extent and Probable Quantity—Geology of the Region

By Arthur Lakes

THERE is no lack of coal in Canada, from lignite to bituminous coking coal and anthracite. In eastern Canada the coals are bituminous and coking and belong to the Carboniferous period. In Ontario there is no coal. In the west from British Columbia to the Pacific Ocean coals of various kinds abound. The coal in this region, unlike that of the eastern fields, belongs from the Mesozoic to the late Tertiary. Manitoba, Saskatchewan, Alberta, Vancouver, and British Columbia contain the most important coal fields. In Manitoba the coal-bearing rocks occupy a small area in the southern part underlying an elevated portion called Turtle Mountain, noted for a landslide which overwhelmed the village of Frank, lying at its base, and killed many of the inhabitants, in 1903. The cause of this catastrophe is attributed by some to the undermining of the mountain by working its coal seams.

The Saskatchewan areas lie in the southern part and are mined on the Souris River. There are about 4,000 square miles in which coal may be found.

Alberta is liberally supplied with coal. The western border of the southern part of the Province consists of ranges of mountains formed of rocks on which the coal was originally laid down. The beds were afterwards uplifted and eroded, removing much of the coal but in the wider valleys remnants of the deposits are found. These from the superior quality and amount of coal form very valuable coal fields. East of the foot-hills lies a great extent of coal-bearing rocks undisturbed. The coal is domestic and within the settlement region it is known as the Edmonton coal and extends north to the international boundary, covering an area of 10,000 square miles, whilst another area further southeast has an additional area of 5,000 square miles, known as the Lethbridge coal field.

The eastern British Columbia areas are of great importance; their structure is related to that of Alberta.

The coal at Edmonton was noted by Sir George Simpson in 1841. Father De Smet crossed the mountain in 1845; passing Rocky Mountain House, he observed coal in the foot-hills and on the stream banks. In 1857 Sir James Hector found coal on Souris River and at Edmonton and Red Deer River and stated that the coal was satisfactorily used in the forges. In 1860 he saw coal seams on the Athabaska and Pembina, near where the Grand Trunk Pacific Railway crosses that stream.

Doctor Grant reported, in "Ocean to Ocean," vast beds of coal on the Brazeau River. In 1873 Doctor Selwyn descended the Saskatchewan and examined the coal seams for the Canadian government. Discoveries of coal near the international boundary were made during the progress of the survey of this line. Dr. G. M. Dawson, who accompanied the survey as geologist, reported on the geology and the evidences of coal under the plains. The coal seams of Blackfoot were recorded by Prof. John Macoun in the report of the Canadian Pacific Railway Survey for 1879.

Coal development followed railway extension. In 1888 coal was

Map of Western Canada Coal Fields. Shaded Portions, Coal

found near Banff opposite the present Bankhead mines. The Lethbridge mines were opened in 1886, those now noted at Canmore in 1888. Near Medicine Hat coal seams on the Saskatchewan have been mined since 1883. The Crowfoot seams were worked by the Blackfeet Indians. The progressive development of the Edmonton mines followed the growth of the settlement and developed rapidly on the advent of the railway and by consolidation and increase in capital. The greatest amount of mining has been along the line of the Crow's Nest branch of the Canadian Pacific Railway in the mountains. This followed on the completion of the railway and within recent years. It is the most important field at present in western Canada or British Columbia.

GEOLOGY

The coal is found in three distinct horizons in the Cretaceous separated by shales of marine origin. The lowest is the base of the formation and is considered Cretaceous from its fossil flora.

It lies just above the Fernie strata of Jurassic age. These shales pass upwards into sandstones containing coal seams called the Kootanie formation, supposed to be of early Cretaceous age. Above these the Dakota sandstone group is not coal bearing. Land conditions suitable for coal forming were not present till the Judith River formation is reached.

The third coal horizon is at the top of the Cretaceous and includes part of the old Laramie formation. The upper part in Alberta is a freshwater deposit classed as Tertiary. In Alberta it is called the Edmonton formation, the highest member of the Cretaceous, bearing many lignite seams.

The three coal horizons are:

1. Edmonton formation in Alberta and Laramie in Saskatchewan.
2. Belly River (Judith River) formation.
3. Kootanie formation.

In eastern British Columbia the Crow's Nest area contains 230 square miles of coal lands estimated to contain 22,000,000,000 tons of bituminous coal. North of this on Elk River is an additional area of 140 square miles with estimated 14,000,000,000 tons.

Alberta.—The Kootanie coals occur in narrow bands in the mountains. The Coleman area, 45 square miles, 50 feet of coal, estimated content 2,000,000,000 tons.

Blairmore-Frank area is irregular in shape and broken by faults, its area is 50 square miles, with 30 feet of coal, estimated content 1,500,000,000 tons.

Livingstone area north of Blairmore, 60 square miles, content same as Frank.

Moose Mountain area outside the first range of the Rocky Mountains consists of a narrow band encircling the mountains, 15 square miles, thickness of coal 15 feet, content same as Frank.

Cascade area is a long strip between the ranges, with seams for 40 miles. It contains 400,000,000 tons of anthracite and of softer grades 1,200,000,000 tons. Paleser area, Panther River, 20,000,000 tons. Costigan, 60,000,000 tons of bituminous coal. Big Horn area between the Saskatchewan and Brazeau rivers, 60 square miles, 1,400,000,000 tons. In the Belly River formation is an enormous area where the coals grade from lignite to bituminous, its area is 25,000 square miles; 5,000 square miles are valuable; 4 feet of coal would furnish 13,000,000,000 tons.

The amounts contained in the two Provinces, respectively, in tons, are 10,000,000,000 for Alberta and 3,000,000,000 for Saskatchewan.

The Edmonton formation in Alberta contains lignites and bituminous coals. The foot-hill areas have a length of 400 miles or an exposed area of 2,000 square miles containing 11,000,000,000 tons. The area is enormous embracing a surface of 10,800 square miles with 6 feet of coal below it at a workable depth, content 60,000,000,000 tons. The total of the formation is an area of 12,800 square miles with a coal content of 71,000,000,000 tons. In the Laramie formation the coals are all lignites. It has a total of 15,000,000,000 tons. The grand total is estimated at 143,490,000,000 tons. In eastern British Columbia the mines of the Crow's Nest district began shipping in 1899. The demand for a steam and coking coal for the mining districts of the Western States and British Columbia caused a rapid increase in a few years. Coal for railways use has been extensively drawn from this field.

GENERAL GEOLOGICAL CHARACTER OF THE COAL-BEARING REGION

The most prominent feature of the coal region is the Rocky Mountains. This consists of a series of inclined blocks of the harder rocks upon which the softer Cretaceous beds lie. The three provinces east of the mountains, though called plains, are undulating tablelands. The first is a plain lying on the Archean floor from which all but the Paleozoic rocks have been removed. This in Manitoba is smoothed over by the sediments of the ancient Lake Agassiz. The second is a plateau of Cretaceous rock. The third is largely of sandstone. The fourth is the true foot-hill area, consisting of inclined hog backs parallel to the Rockies. The metallurgical market in Canada is British Columbia and Ontario. On the main line of the Canadian Pacific Railroad there is no coking coal.

For domestic and manufacturing purposes the coals of the plains maintain their market against the higher grade coals of the mountains and foot-hills, owing to short haulage and cheapness.

For power purposes and stations the lignites are adapted for gas producers.

For railway power the supply will have to come from the mountains.

GENERAL GEOLOGY

At the eastern edge of Manitoba, and extending northwesterly is the old Archean floor covered by successive beds of Paleozoic shales and limestones covered in turn by Cretaceous sandstones. The lower beds on the Saskatchewan are Triassic and Jurassic containing fossils. The Kootanie group, the most important coal bearing, rests on the Jurassic in the

Rockies. It is recognized in Montana and Dakota. It consists of sandstones and shales containing many coal beds. In places it is 5,300 feet thick, at Blairmore it is only 740 feet; elsewhere it ranges from a few hundred to 2,000 or 3,000 feet. Its fossils are plants, ferns, cycads, and conifers.

At Edmonton and in Alberta and southern Saskatchewan, the coal belongs to the Laramie or Upper Cretaceous. The deposits are a brackish-water transition series between the marine clays of the Pierre and the fresh water of the Tertiary. Fossils are Dinosaurian remains, land plants, and brackish-water shells. Early Cretaceous deposits follow the shallowing of a sea in which little of the present continent was submerged. The close of the Cretaceous is marked by an emergence from the sea; but during the periods of oscillation between land and shallow-water conditions, when the surface remained near sea level, an abundant flora appears together with brackish-water forms of animal life. The coal bearing area of this phase of the retreat of the sea is called the Edmonton series in Alberta. At the close of the Laramie period was the rise and elevation of the Rocky Mountains.

This movement was caused by a great lateral force shoving the crust from the southwest and forming anticlinal arches or ridges.

The economic value of the Cretaceous rocks lies in their coal-bearing beds. Although mainly sea deposits, there are three horizons showing land conditions and evidences of plant life, and in these beds coal seams have been found.

A marine invasion of the central part of the continent during Cretaceous times was preceded, in the then existing low trough of the present Rocky Mountain area, by an abundant flora, so that the early Cretaceous was coal bearing. These beds, known as the Kootanie series, were subsequently covered by shales deposited by an invasion of the sea. A shallowing of the sea over the western part brought about land conditions again in later Cretaceous times, and vegetation spread eastward, and was in turn buried by shales by the last invasion of the sea. At the close of the Cretaceous, when the continent finally emerged from the sea, and while land surface oscillated at or near sea level, another mantle of vegetation covered the low ground, and coal seams were formed. Fossil impressions of leaves, stems, and petrified wood show an increasingly changeable climate and an increasing altitude. The three coal horizons thus formed are: The Edmonton-Laramie formations; Belly River formation; Kootanie formation. The quality of the coal varies with the age of the formation and the amount of the covering beds. The lateral disturbance and pressure on the formation of the Rockies has made great changes in the nature of the coal. Thus in the flat regions of the Edmonton series the coal is lignite with 20 per cent. moisture, but in the disturbed area near the mountains it grades to true coal. In the Belly River, similarly, the lignites grade to nearly coking coals.

The Kootanie coals, having been subjected to greater load and pressure, are better coals; and as they mostly occur in the disturbed and faulted borders of the mountains they range from coking coals to anthracites, the greatest alteration being near Banff. The flora found on these Cretaceous coal beds are mostly of a semitropical nature or temperate or subarctic. The California Sequoia and various pines and poplars, for example, are characteristic of some formations, whilst the magnolia, plane tree, and catalpa are found in others. The one implying a northern, the other a southern, type. From the lists given by Dawson & Newberry* in Mr. D. B. Dowling's report on the coal fields, we do not see the palmetto species mentioned which is so common in the Laramie coal beds of Colorado. Ferns and other aquatic plants are very common showing the swampy character of the country in which the coal was formed. The leaves of trees were probably blown into the swamps from trees grown in the neighborhood, whilst their decayed trunks were carried thither by streams and freshets. The low growing swamp vegetation was that which mainly formed the coal beds, just as mosses from the peat in the swamps of today.

In the Kootanie series at the base of the Cretaceous within the mountains, the coal fields are in long narrow strips between the ranges. The thickness on Elk River is 4,700 feet, in which there are 22 workable seams. The series is found in Alberta and British Columbia. This is the Elk River or Crow's Nest field the most important in Canada. The top of the formation is a coarse conglomerate, the rest is a succession of coal seams between shales and sandstones.

In British Columbia the Fernie district has an area of 230 square miles. The coal-bearing rocks are 4,700 feet thick. There are 22 workable seams with a total of 216 feet of coal, 100 of which is workable, giving a total of 22,600,000,000 tons. The coal is high-grade bituminous, occasionally anthracite; the seams are largely used for coke. The area extends into Alberta at Crow's Nest and Blairmore and Frank areas; these are bituminous coking coal areas; in Moose Mountain is a seam 20 feet thick. On the Cascade River coal varies in composition from bituminous to anthracitic, of which there is a total of 1,200,000,000 tons.

The second coal horizon lies above the Kootanie formation; the principal exposures are on the Belly River at Lethbridge colliery. In Alberta the coal-bearing portion is called the Edmonton formation. A trough was here filled along the center by Tertiary beds. The effect of pressure has consolidated and improved the coal. The "Big Seam" near Edmonton is 25 feet thick and is exposed along the river. In Manitoba the Turtle Mountain area is most noted for coal. Mr. D. B. Dowling's report to the Canadian Survey, from which our knowledge of these Canadian fields is derived is limited in British Columbia to the eastern fields of that Province, but

*"Coal Fields of Manitoba, Saskatchewan, Alberta and Eastern British Columbia," by D. B. Dowling, Geological Survey, Canada Department of Mines.

there are important fields in the central portion, such as those of Princeton and Nicola, whilst the well-known field of Vancouver has its importance from being on the sea coast and supplying the maritime area along the Pacific.

Testing for Carbon Monoxide

Written for The Colliery Engineer

The most dangerous gas met in coal mines is carbon monoxide, the product of incomplete combustion. As it is the product of incomplete combustion it has long been known to be the chief cause of death after a dust or gas explosion, and rescuers on that account keep out of an exploded mine until a ventilating current is put in motion, and even then none but helmet men should venture ahead of the air.

In the absence of other apparatus, small animals, birds, or a chicken can be taken into the mine, and as they will succumb to the effects of small percentages of *CO* before it will seriously affect a man, the effect of the gas on them can be used as a warning of grave danger. It is not meant, however, that the effect of the gas on the bird or small animal will measure the percentage of the gas present, as is shown by the experience of Sir C. Le Neve Foster noted below.

H. Letherley, late Professor of Chemistry and Toxicology in the Medical College of the London Hospital, states that ".5 per cent. of *CO* killed small birds in 3 minutes; 1 per cent. killed in one-half the time; 2 per cent. rendered guinea pigs insensible in 2 minutes." Sir C. Le Neve Foster in speaking of his experience in testing for carbon monoxide gas with mice at the underground fire, which occurred at the Snaefell Lead Mine, Isle of Man, May, 1897, said: "On the whole I must confess that the test with the mouse does not appear to me to be so delicate as supposed by Doctor Haldane."

Robert Lamprech in his book, "Recovery Work After Pit Fires," published in 1900, says: "When the amount of carbon monoxide in the air attains .06 per cent., human blood will take up 30 per cent. in an hour to an hour and a half, so that symptoms of poisoning are exhibited in a worker so soon as he begins to exercise his strength; .10 per cent. will produce helplessness at the end of an hour; with more than .20 per cent. of carbon monoxide in the air, life is endangered, and when there is over 2 per cent. death occurs before the blood has had time to attain the maximum degree of saturation."

When a fire is suspected to lie smouldering in some worked-out portion of a mine, the proof of its existence can be determined by an analysis of the return air, and if it be necessary to make an examination to ascertain its extent, helmet men should be employed.

Potain and Drouin advanced the use of a dilute solution of palladium chloride as a test for carbon monoxide. In 1898 they stated that "one part of carbon monoxide in 10,000 of air could be detected by this means." The apparatus employed was a long tapered tube connected with the supply of gas under examination and dipping to the bottom of an outer tube containing the reagent composed of 10 cubic centimeters of a one ten-thousandth solution of palladium chloride, and 2 drops of hydrochloric acid.

The outer tube was attached to an aspirator and the air drawn in slowly through the reagent which formed a column of liquid about 8 inches in depth, from which palladium is precipitated so as to discolor the liquid. The volume of air containing the carbon dioxide being known, the percentage of *CO* is ascertained by the degree of dilution requisite to reduce another portion of the palladium solution to the same shade as that discolored.

In December, 1911, Prof. W. R. Crane read a paper on "Special Method of Testing for Mine Gases" before the Coal Mining Institute of America, in which he described the Simonis carbon monoxide detector, based on the principle that platinum or palladium chlorides are reduced to the metallic state by carbon monoxide. He states that the gas to be tested must be freed from ammonia and hydrogen sulphide by passing it through copper sulphate or sulphuric acid solutions, after which it is passed through a tube in which is placed a strip of paper sensitized by being saturated with either the chlorides of platinum or palladium.

Table 1 given is for platinum chloride which is more sensitive to carbon monoxide reactions.

Table 1.—Reaction of *CO* on $PtCl_4$

Percentage of *CO*	Reaction Visible After		Strip Turns Black
	Minutes	Seconds	Minutes
.01	11		60
.025	5		32
.05	3		16
.075	2		12
.10	1		9
.25		44	6
.50		26	4
.75		20	3
1.00		16	2
2.00		15	2

This detector has been used with gratifying results by J. R. Campbell, of the H. C. Frick Coke Co., who has modified the apparatus somewhat and made it more adaptable and convenient by placing a sponge in the bottom of the main containing receptacle, thus permitting dry test papers to be used instead of wet or moist ones as was necessary in the original apparatus. With the addition of the wet sponge, or humidor, the dry gas takes up sufficient moisture to produce a chemical action on the test paper. This is a decided convenience because test papers may be prepared and carried indefinitely, being always available for use without further preparation.

When used in the mine some means of passing the gas through the apparatus is necessary, and this is accomplished by using a pump or india-rubber inflator. Fair results may also be obtained by opening the apparatus and leaving it in the mine for any desired length of time; the gas will diffuse through the instrument and act upon the sensitized paper. There is no doubt, however, but that better and more reliable results may be obtained by causing

a positive current of gas to pass through the apparatus.

The following test using palladium chloride is given by R. Nowicki in *Oesterr. Zeitschr. fur Berg und Huttenwessen:* It consists of a glass vessel or bulb, with a cock at the top, connected to a small rubber bag, for admitting the air. Inside the vessel is a piece of paper soaked in palladium chloride. If the air when admitted contains carbon monoxide, the paper changes from brown to black, and by the length of time required for this chemical reaction the percentage of carbon monoxide in the air is determined. With a percentage of .01, the color of the paper begins to change in 11 minutes, and becomes perfectly black in 60 minutes. If the air contains 2 per cent. of carbon monoxide, the first change of color is perceptible in 11 seconds, and the paper turns a dead black in 2 minutes. Intermediate percentages of carbon monoxide are shown by proportionate intervals of time. Thus, if the air contains more than 1 per cent. of carbon monoxide, its presence can be immediately detected by the change in color of the paper.

Lake Superior Mining Institute

The next meeting of the Lake Superior Mining Institute will be held on the Mesaba Range at various places to be selected by the local committees. Arrangements are under way by the general committee at Duluth, Minn. The Council has decided on the meeting being held Tuesday, August 26, and continuing to Saturday, August 30. Since the last annual meeting the president has appointed Willard Bayliss, superintendent, Chisholm, Minn.; E. D. McNeil, general superintendent, Virginia, Minn.; and S. J. Lutes, superintendent, Biwabik, Minn., a special committee on "Mining Methods on the Mesaba Range." Address A. J. Yungbluth, Secretary, Ishpeming, Mich.

Hogan on the Taxation of Anthracite

Well Reilly, I see be the paapers that the Gov'nor of Pinnsylvania has signed the bill taxin' hard coal two and half per cint. As near as I can figger id out, this manes that the coal companies must pay five or six cints tax on ivery ton iv coal they projuce for market.

There's a quare lot at Harrisburg makin' laws fer the Sthate, Reilly. Sure from the way they act and the laws they pass, you'd think the coal companies, or the officials at laste, were almosht if not quite criminals, and that fer the good of the counthry they musht be taxed out iv business. Mebbe 'tis fer the good iv the counthry, but I've me suspicions 'tis fer the good iv a lot iv politicians' pockets, and d'ye mind who it is that's eggin' thim on. Sure if ye had sane the list of clargy, shmall-fry lawyers and clarks that have been in Harrisburg urgin' the Legislather to pass and the Gov'nor to sign the bills, you'd think they were diligates to a Sunday-school convintion. Insthead iv that, they were lobbyin' and consoortin' wid min manny iv thim wouldn't vote for, an' I dunno but that they tuk a dhrink or two wid some iv thim, aven if at home they do be denouncin' the same.

I'm not sayin', Reilly, that all the Honorables in the Legislather of Pinnsylvania can be infloo'enced wid a dhrink or two. There are some iv thim that can only be infloo'enced be a bit iv paper wid a yellow back, an' there are others who can't be infloo'enced be aither, but they're few, an' begorra, Reilly, fwhat bates me is that this few are infloo'enced be the hullabaloo med be a crowd of min that seem to think corporations are like heads at Donnybrook Fair—med only to be hit.

I raymimber wan Foorth of July I heard a lad make a spache that sounded fine. He had a grate flow iv words. Mosht iv thim were simple an' plain, but sez he in wan place, "Vox populi vox Dei." That wuz Latin, but the only part iv it I raymimbered bein' in me prayer book was Dei, an' I knew phwat that mint, an' judgin' be that I thought Father McGovern could tell me phwat it all mint, and he did. Says he, Hogan, it manes the "Voice of the people is the voice of God," an' thin he told me there wuz enough truth in the sayin' to make id dangerous. Sez he, "Hogan, whin the voice of the people, an' *all* the people, is for good, 'tis the voice of God, but the mob is not the people, an' the voice of the mob is the voice of the Divil."

Now lave us look at this new tax like sober, sinsible min. In the fursht place the coal companies pay a tax to the Sthate the same as other companies. Thin, they pay another tax to the county, an' iv their mines are in a borough or city they pay another tax. Now the new tax comes. The excuse fer id is that hard coal is gettin' scarce, and whin it is gone the mines will be gone too, an' there'll be nawthin' to tax. That's thrue, Reilly, whin the coal 's all gone there'll be no mines. But ivery day that passes makes the owners iv the mines poorer to the extint iv the coal taken out. Av coorse, they make a profit on the minin', and iv they're shmart they save enough iv the profit to pay the price they ped for the land. But aven so, the time comes whin they'll have no mines to be gettin' a profit from, and thin, aven if forehanded, they'll only have the price they ped for the land manny years ago, which wasn't much.

I see that the lads that pushed the law through say that the tax will be ped be the consumer. Av coorse it will iv the consumer has the price. But iv the consumer is a poor man, or a workin' man out iv a job, and manny consumers are iv that kind, mind you, 'tis hard lines to make him pay more for coal to kape his house warrum and to cook his bite to ate.

I don't know much law, Reilly, but I've read a dale about phwat

the Shuprame Coort does to fool laws. I dunno phwat they'll do to this wan.

Besides, Reilly, shuppose we have hard times agin, and begorra, there are lots iv wise min ixpictin' the same, who'll pay the tax if the Shuprame Coort lets it sthand? Iv the times get hard enough to cut down the demand for coal, the price iv id will dhrop. Whin it does dhrop, as it has befoor, to a pint that gives the companies little or no profit, who'll pay the tax? It won't be the consumer, thin, Reilly? 'Twill be the min that projuce the coal. Wages, Reilly, are ginerally regulated be the price the product iv labor brings, an' the difference bechune the cosht iv production and the price it's sold at is profit. Cosht iv production don't mane wages an' royalty alone. It manes ivery ixpinse at the mines. Whin prices dhrop, ixpinses musht come down too. Ivery ixpinse that can be rejuced musht be. The taxes can't be rejuced,' an manny other ixpinses can't, but wages can be, an' thin 'twill be the min at the mines that will be payin' the tax.

The same lad that I wuz tellin' ye about that sed, "Vox populi vox Dei" in the Foorth av July spache. also sed that the fundamental principle iv the American government was aiquality. That all classes iv min were to be traited aiqual in all matthers pertainin' to law. I belave, from phwat the Declaration iv Indepindence and the Constitushon sez, he wuz right in this. Iv he was, Reilly, the same crowd that put the new two and a half per cint. tax on coal will have to put id on other products as well, iv they want to have the tax on coal sthand. It is only raisonable to say that iv id's right an' lawful to tax hard coal that way, 'tis just as right an' lawful to tax soft coal the same. Besides, iv id's right to tax the coal projuced, it is just as right and raisonable to tax the iron and stheel, or the corn an' oats, or potatoes, or shoes, or annything else projuced in the sthate. Begorra, be the same token, Reilly, they ought to tax Dominic Pasquale, the little Dago cobbler, that minds me shoes, for aich new half-sole he puts on thim.

I dunno, Reilly, phwat the country's comin' to. 'Twas hard times we had in the coal ragions befoor the big companies were formed, an' now that we're havin' good times, there sames to be a lot iv lads in polytics that do be thryin' their besht to hindher thim.

National Conservation Exposition

The National Conservation Exposition which takes place in Knoxville, Tenn., will hold a "Miners' Field Day," on September 20, 1913.

A feature of the day will be an explosion of coal dust in the steel tube belonging to the Bureau of Mines, which will be shipped to Knoxville for the occasion.

On this day it is expected that several thousand miners from the coal mines in Tennessee, Kentucky, Alabama, and the Virginias will accompany their respective First-Aid and Rescue teams to this meet.

The prizes in this contest will be many and valuable. For the three best teams in first-aid to the injured work, the American Red Cross will give medals and certificates. The American Mine Safety Association will give medals of gold, silver, and bronze to the best teams in general all-around work. Other prizes will be given by operators, by miners' supply houses, by makers of mining and safety apparatus, by The International Textbook Co., and by The Colliery Engineer.

All of the mine owners in the surrounding districts have agreed to close their mines on that date, in order that their employes may go to Knoxville for the Field Day.

According to the officials of the United States Bureau of Mines, this will be one of the largest meets of its kind ever attempted, and doubtless it will add greatly to the interest in first aid in that part of the country.

Mine Fires

In a paper on "Underground Fires," read before the Mining Institute of Scotland, April 12, 1913, Mr. Henry Rowan, of the Fife Coal Co., says:

In my opinion, the heating causing the fires is due to the falling in of the small ribs of coal which have been left to protect the men when opening out the working places. This is due to the grinding caused by the subsiding strata. It has been proven conclusively that gob fires are most prevalent where there is weak roof. Various proposals have been put forth as the best means of dealing with active underground fires, such as digging out the fires, isolation by sealing them, and by hydraulic stowing, and all these have their uses.

The whole problem is of great importance, and one is forced to the conclusion that some form of hydraulic stowing would be the most effective method of preventing such disturbing occurrences. The grinding due to the subsidence of the overlying strata would be very greatly reduced; fewer small pillars would be left in the waste, because the fallen-in places would be reduced to a minimum; all the interstices would be filled by this method of stowing, and so prevent short-circuiting of the air.

The most disturbing problem in connection with underground fires is the safety of the men. Serious trouble has been experienced at various times from carbon monoxide, and various means of guarding against the dangers due to the presence of this gas have been adopted, such as litmus paper saturated with palladium chloride hung in an airway on the return side of the fire, mice in cages have been employed extensively, and also canaries, for experience has shown that a person is quite safe to work in the vicinity of an underground fire if he has beside him a cage containing a small bird, because the bird will fall from its perch long before a man becomes affected with the gas, thus giving time for escape.

Coal Mines Under the Sea

Written for The Colliery Engineer

The Inverness coal field, in Cape Breton Island, consists of a number of detached synclinal basins, so nearly submerged under the sea that in several instances only the mere lip of the basin is preserved on the land. The seams dip under the sea at very steep angles, and rapidly gain cover, as the sea floor has a moderate dip only. In some cases the crop of the upper seams has been steadily encroached upon by the rapid erosion of the shore line, and seams have been lost in this manner within quite recent times.

In January, 1909, the Mabou mine was flooded from the ocean by a break in the roof of the slope, and in June, 1911, the Port Hood colliery was inundated by a feeder from the roof following the extraction of pillars, at a point where 942 feet of solid strata were supposed to lie between the coal seam and the floor of the ocean. The coal seams of Nova Scotia are the property of the Government, and as charges of improper methods of mining were made, and criticisms of the Mines Department were freely aired in the Provincial House, a commission of reputable engineers was appointed to investigate the causes of the two inundations.

The commissioners were unable to find any violation of good mining practice, but they recommend that in future "every reasonable means should be employed to ascertain the depth, nature, and condition of the overlying strata before pillars are extracted in any submarine area."

The water in the mine ebbs and flows with the tide, but the actual rise and fall in the mine is much less, owing presumably to the retardation of friction in the mine itself and in the fissure which it is presumed communicates with the ocean. The mean difference between high and low readings of the tide gauge at the shore was 3.14 feet, whereas the corresponding difference between the levels in the mine was .82 feet.

The report does not recommend an attempt to unwater the mine, and advises that any further expenditure which may in the future be made should be on openings on the intact portion of the seam.

In the case of the Mabou mine the distance between the roof of the seam on which the slope was sunk and high water mark was only 110 feet, and from the frequency of small faults in the Inverness coal field and the great angle of dip the Commissioners consider that "it was an error of judgment to have entered this seam under this comparatively thin cover," an opinion with which most miners would agree. The report does not advise any attempt to unwater the present slopes, and recommends that any future workings be opened on one of the lower seams.

The submarine coal deposits off the shores of Cape Breton Island are in all probability very much more extensive than the hitherto worked land deposits, and on the eastern side of the island in the Sydney coal field they are for all practical purposes illimitable except by problems of haulage, pumping, ventilation, etc. On the eastern side the coal seams dip under the ocean very gently, and the whole field is surprisingly free from faults or dislocations of any kind. The workings of the Nova Scotia Steel and Coal Co. and the Dominion Coal Co. extend under the sea for distances ranging up to 2½ miles from high-water mark, and in the future the bulk of the coal output will be drawn from submarine areas. Every precaution is taken to ascertain the thickness of the cover, and its nature can be judged from the rock exposures along the shores. It will be generally admitted, however, that no pains or precautions are too great to preserve this vast submarine coal wealth from any possibility of inundation from the sea, or to keep intact the access to the coal seams from the land. As it is probable from geological indications that the submarine field off Glace Bay extends for at least 7 miles from shore—and how much further no one knows—it will be seen that some very interesting problems in auxiliary haulages and ventilation, in underground power transmission and the conveyance of men to and from their work, will have to be solved by the engineers who may have charge in the future days.

The present regulations governing the extraction of coal in Nova Scotia under submarine areas, provide that no coal shall be wrought under a less cover than 180 feet of solid measures. Passageways to win coal may, however, be driven under a cover of not less than 100 feet of solid measures. Where there is less than 500 feet of solid cover submarine workings must be laid off in areas of not more than half of one square mile, each area being surrounded by barriers of coal not less than 90 feet thick, pierced by not more than four passageways having a sectional area not greater than 9 feet wide and 6 feet high. Before work is commenced in any submarine area the plans must be approved by the Inspector of Mines, and every new lift or level in a submarine mine is understood to be a new winning, requiring the sanction of the Inspector. Under the present laws no regulation has been attempted of the method of coal extraction where the cover exceeds 500 feet, except the provision that every new lift must have the approval of the Inspector.

It is evident, therefore, that some amplification of the existing regulations has become desirable from the experience in the Inverness coal field. Some time ago the government of Nova Scotia engaged the services of an English mining engineer with long experience in submarine mining to make a report on Nova Scotian conditions, and it may now be anticipated that legislation will be enacted embodying the recommendations of this gentleman and the commissioners whose report is above referred to.

Working an Inclined Coal Bed

A Description of a Method of Working a Pitching Seam at Coal Creek Mine, New Castle, Washington

By George Watkin Evans*

THE following method of working a pitching coal seam is practised at the Coal Creek mine, New Castle, Wash., where the average dip of the bed is 38 degrees. Here what is called the "Ford slope" has been sunk on the Muldoon seam, and as a mine it has an average daily capacity of 1,000 tons. The property is owned by the Pacific Coast Coal Co., which also operates the collieries at Black Diamond and Franklin, King County, and the Burnett colliery in Pierce County, all in the state of Washington.

The Ford slope is about 19 miles by rail to the southeast of the city of Seattle, on the Columbia and Puget Sound Railroad. The greater portion of the coal is consumed in Seattle and other Puget Sound cities.

The product from these collieries is in reality a subbituminous coal, though erroneously called lignite, and while not high grade compared with the good coals of the East, does very well, and finds a ready market as a domestic fuel during the greater part of the year. The Muldoon coal seam Fig. 1 is one of 10 beds occurring in this series, three of which are being worked, and another, the Bagley, has been operated at various times.

All the coal beds in King County belong geologically to the Puget Sound Series, a subdivision of the Eocene period, which in this particular case extends from a point near the eastern shore of Lake Washington, eastward and northeastward through the Pacific Coast Coal Co.'s property, on through the property of the Issaquah and Superior Coal Mining Co., Ltd., then to the northeast through the property of the Central company, which operates the Grand Ridge collieries.

The coal beds in this belt are not so badly faulted and folded as are those in the western part of Washington, although they dip to the north and the northwest at angles varying from 35 degrees at a point west of New Castle to 38 degrees and 40 degrees at Coal Creek, and from about 30 degrees to 26 degrees at Issaquah. Near Grand Ridge the strata flatten to 23 degrees, and then become as steep as 65 degrees at the northeast margin of the belt.

The coal measures at Coal Creek are about 950 feet thick. Overlying the productive coal measures are several beds of inferior coal, none of which are mined. Beneath the coal beds, sandstones, and shales of the coal measures, is a large mass of igneous rock, which is probably younger than the coal series and no doubt had direct influence on their uplift and their present dip to the northward. New Castle, Squak,

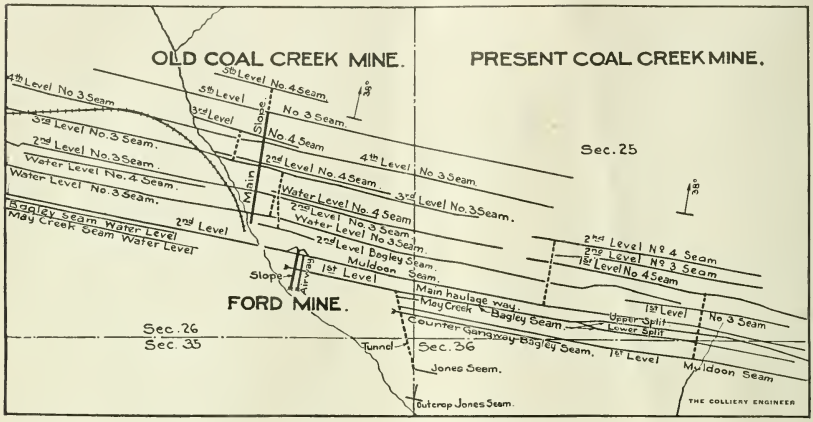


Fig. 1. Map of Mine at Coal Creek

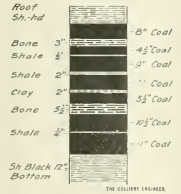


Fig. 2. Section, Muldoon Bed

*Consulting Coal Mining Engineer, Seattle.

Issaquah, and Tiger Mountains, are composed of the same kind of igneous rock as that below the coal measures.

Fig. 2 is a detailed section of the Muldoon bed. Fig. 3 is a section of the coal measures taken in the rock tunnel at Ford mine, from No. 4 bed downward.

It will be seen that the Muldoon bed has a shale roof and a shale floor, and that the nearest workable bed is the Bagley, 130 feet above. The roof and the floor of the Muldoon bed are smooth and separate readily from the coal. In most places the roof is strong, but in some instances it is more brittle. To find a satisfactory method of mining this bed, the present management have done considerable experimenting, in the course of which the following satisfactory systems of working were evolved.

The officers in charge of this property are progressive and are modernizing each of the company's collieries. Prior to becoming local superintendent, Mr. J. J. Jones studied the systems of working in operation under former managements, and also local conditions. Several of the older systems resulted in serious mine fires, while the present system has been instrumental in avoiding fires, has lowered the cost of production, and has proved a very safe method of working.

Accidents are rare in this mine, except minor cuts and bruises which are incidental to any kind of labor. However, since the Compensation Act has gone into effect in this state, these minor hurts have been elaborated upon by some of the miners, so that what were previously regarded as trivial bruises have now been classed by some men as more or less serious.

Safety is the watchword of the management, after which comes the cost of operating.

Everything connected with the colliery and outside arrangements has been thoroughly systematized, cost diagrams of all operations are posted every day so that the man in charge of any department can make comparisons.

The coal in the Muldoon bed is mined by a retreating system, the details of the operation depending on the character of the roof. The method of mining practiced on the east side of the Ford slope, where the roof is brittle and not so strong as on the west side, is shown in Fig. 4.

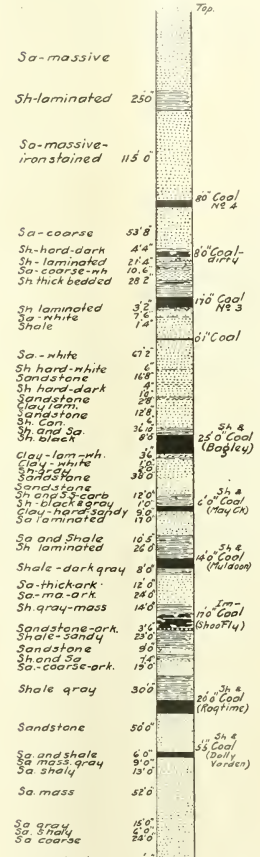


Fig. 3. Section, New Castle Coal Series

The gangway, which is the intake airway, and the return airway are driven parallel, with breakthroughs 10 feet wide connecting them every 70 feet. After the boundary line of the property is reached, the inside breakthrough is driven 12 feet up the pitch to act as a chute and room neck, after which it is widened on the right hand, or outside, from 10 feet to 30 feet. While the room or breast *a* is being driven, other breasts, *b*, *c*, *d*, etc., toward the slope, are started so that the faces of the breasts are stepped back about 100 feet, as shown in Fig. 4. Breakthroughs with an area of 16 square feet are driven every 60 feet for ventilation.

Plank chutes about 5 feet wide are placed about 4 feet from the inside rib, so that the coal as broken may be directed into them by wings of sheet iron. In case the coal will not slide, it is "bucked" down to the gangway, where it is loaded into mine cars. Batteries of 8"×8" timbers are built every 100 feet in the breast to arrest the progress of the coal, and when the chute is filled to the next battery above, the chute boards are withdrawn to let the coal slide to the battery below or to the gangway. This method of moving the coal has reduced the breakage materially, over the older long slide method.

All of the material between the walls of the bed is taken out and separated at the picking tables and washer.

When the gangway pillar above, which is usually 125 feet wide, is reached, as for example in breast *b*, a chute *i* is driven diagonally up the pitch and into the edge of the pillar on the side of the breast. A block of coal immediately above the breast is left intact to protect the men during the pillar mining; and to afford them a safe retreat when a fall of roof occurs. After the upper section of the pillar is mined, the protecting block is worked away and that portion of the breast usually caves, thus relieving the pressure

from other portions of the pillars. The next section of pillar below is mined in precisely the same manner.

After a number of breasts have been mined and allowed to cave, the gangway pillars are removed and this part of the gangway is allowed to cave. It has been found that by this method almost all the coal can be extracted, the men are thoroughly protected, and that there is absolutely no danger from spontaneous combustion.

In Fig. 5 is shown the method used until recently in mining this bed west of the Ford slope.

A main and a return entry were driven parallel to the boundary of the mine, breakthroughs 10 feet wide were driven every 100 feet, which afterwards were used as chutes. When the boundary line of the property was reached, the inside breakthrough was driven 12 feet above the return airway and widened to a 50-foot room. The next room worked the same way left a 50-foot pillar between the rooms which were worked to the gangway pillar above. Plank chutes about 6 feet wide were carried up the center of the breasts and wings were built every 100 feet to pile up and to direct the coal into the chute, thereby avoiding excessive breakage. The air circulated through the inside chute back of a brattice to the top of the breast, then down the manway and through the upper cross-cut into the next outside breast.

When the two breasts were completed a chute 10 feet wide was driven from the main gangway through the length of the pillar. The coal was then mined from the pillars and directed into a wooden chute by wings of sheet iron, as shown at *a* Fig. 5. Block after block from the pillar is withdrawn in this manner, toward the gangway, by which time other pillars are being worked. This method of driving breasts and removing pillars is continued outward until the chain pillar at the slope is reached.

Fig. 5 shows the position of the trap doors, chutes, brattice and air stoppings, also the batteries.

A new "block" or "panel" system of mining is being tried on the west side of the Ford slope, a sketch of which is shown in Fig. 6. In this system the two entries are driven to the boundaries of the property, with breakthroughs 10 feet wide driven between them as indicated. When the boundary is reached, two breasts, *a* and *b*, are worked up the pitch simultaneously. The coal is mined very much as described in the other methods, but when the breasts are complete, a chute 20 feet wide is driven to the rise through the center of the pillar. The details of drawing the pillar are shown in the upper part of the pillar between breasts *a* and *b*. A chute is started at a point about 20 feet below the upper breakthrough and is driven diagonally into the pillar above. That portion of the pillar above the cross-cut is then mined and passed down the main chute. The three-cornered stump which is removed last has been found to be absolutely necessary, for it supports the roof and gives the men a safe retreat. This method is then carried down to the next pillar, and so on until all the chain of pillars between the rooms is removed.

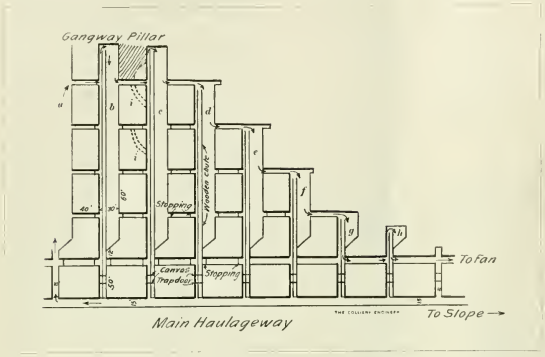


Fig. 4

While breasts *a* and *b* are being driven, breasts *c* and *d* are started, leaving the block between *b* and *c* intact. Breasts *c* and *d* are then driven to the gangway pillar above, the same as *a* and *b*, and the pillars between them removed in the same manner as those between *a* and *b*. After the pillars are removed, chutes *e* and *f* 20 feet wide are driven on the pitch, and the pillars each side of them removed through the 20-foot chutes *e* and *f*.

This system has proved satisfactory because by its practice roof pressures can be regulated properly, ventilation problems simplified, and the miners protected; besides all the coal is removed, and there is no danger from spontaneous combustion.

Sawed lumber is used almost entirely in the mine, for the reason that nearly all the smaller second growth timber was removed many years ago in this district, and now large fir trees are hauled to the company's mill to be sawed into suitable dimensions. Most of the timber used in the mine is sent down the main slope in cars and then carried up to the miners' working places. At times, chutes are driven to the surface and some timber lowered to the working faces.

The coal is run into mine cars from the chutes by "loaders." Each collecting motor has a "loader." Jeffrey and General Electric compa-

nies' 5-ton electric locomotives are used for gathering and distributing mine cars, while a 15-ton electric locomotive is used on the surface for hauling the trips from the top of the slope to the washers.

The motors travel at an average of 833 feet per minute, but much higher rates of speed are sometimes reached. The mine tracks, carefully ballasted with gravel brought from the surface, are kept remarkably free from refuse of all kinds. The pressure carried is 550 volts.

The ditch is made on the "downhill," or dip side of the gangway, and is covered. The gangway is ordinarily 15 feet wide for single tracks and when turn-outs are made the width is 18 feet, which gives sufficient room.

Ordinarily, the only gangway timber used is a collar and two legs, but where the roof is a little brittle lagging is used.

The agreement with the U. M. W. of A. specifies that the miners shall be equal partners in the mine. They are paid $3.80 per day of 8 hours. Mining machines are used, and the miners are paid a bonus for certain amounts above a specified area to be mined with the machines. They get their $3.80 a day and the bonus as well. It is found that by this method the men make considerably over the minimum wage. The plan works well for the men and for the company.

The machines used were designed by the Sullivan Machinery Co., and their method of operation is well described by Mr. Hoye in the September, 1910, issue of Mines and Minerals.

The mine produces very little marsh gas CH_4, and open carbide lamps are used entirely in this mine. The use of calcium carbide began 4 years ago, this company being the first to use this kind of lamp in this state. So far, the lamps have proved satisfactory, and are considered superior to the old-fashioned oil lamps.

The "turn-out" at the bottom of the Ford slope deserves special mention. The slope was driven on the full width of the Muldoon bed, 5 feet 7 inches, and at the bottom a wide rock tunnel was continued some little distance, then easy curves were driven to each side, and back to the bed. Double tracks are used on both sides of the slope, with the grades so regulated that little effort is necessary to start the cars.

Four-car trips are hauled up the slope, but the equipment is such that with slight alterations six or eight cars could be hoisted.

A new lower "lift" or level is being prepared in this slope, and when the upper-level coal is worked out everything will be in readiness so that coal can be hoisted from the lower levels, and the tonnage increased to whatever limit the market requires.

Messrs. James Anderson, manager; William Hann, general superintendent; and John J. Jones, local superintendent, deserve great credit for the excellent conditions prevailing at this colliery. During their regime it has been modernized, and they have transformed what had formerly been the scene of a series of mine fires, labor troubles, etc., into a well-equipped, money-making coal mine.

The profits on this grade of coal are not large, so that it requires careful management to place the balance on the right side of the ledger.

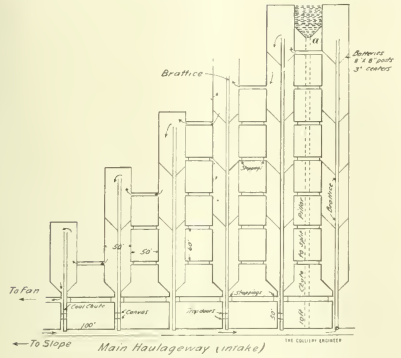


Fig. 5

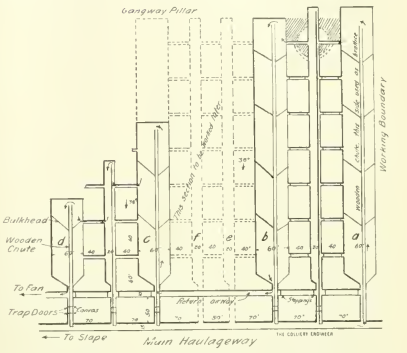


Fig. 6

The American Mining Congress

The Annual Convention of the American Mining Congress will be held in Philadelphia, October 20, 21, 22, 23, and 24, 1913.

It is proposed to discuss in full the coal and iron interests in the Eastern States.

The chairmen of the various committees are: E. T. Cromer, Chairman Finance Committee; Robert H. Large, Chairman Committee on

Transportation; N. B. Kelly, Chairman Committee on Hotels; J. S. W. Holten, Chairman Entertainment Committee; W. R. Roberts, Chairman Publicity Committee. The attendance at an annual convention of the American Mining Congress sometimes reaches as high as 1,200, and because of the immense amount of work connected with these meetings chairmen of the several committees appoint subcommittees.

Kentucky First-Aid Team Meet

The First-Aid Field Meet in Kentucky was remarkable as the first state-wide first-aid contest held in the East. It was an added attraction to the spring meeting of the Kentucky Mining Institute, held in May. Mr. W. L. Moss, of Pineville, Ky., being interested in first-aid work in the Continental Coal Co.'s mines, of which he is general manager, was the prime mover in arranging this contest. Although several of his teams were present, they were unable to capture first prize, but the following day Mr. Moss captured the first prize from the Kentucky Mining Institute, as he was made president.

In the contest, 25 problems were presented, from which five were chosen for demonstration. A little after noon the teams, to the number of 20, in their uniforms, assembled in front of the Union Depot, in Lexington, and, headed by the State University Band, marched to "Stoll Field," at the University, where four companies of cadets received them. After dress parade and guard mount, the teams were photographed, and the contest commenced. Unfortunately, before the exercises were quite finished, rain, accompanied by lightning and thunder, drove the spectators from the field, making it necessary to finish the contest in the Armory.

The Continental Coal Corporation had a special train run from Pineville, which brought a band and 450 citizens who made the day one for enjoyment.

Mr. Ray Moss, who has taken a course of first aid at the Bureau of Mines, Pittsburg, had in his care 12 Continental teams, two of which were colored teams that had a separate competition. This was probably the first public colored team competition ever held, and the $30 cash was won by Rim 3 team, composed of William Smith, Sam Wolfe, John Chambers, George Wade, William Henry, Jasper Coleman, captain. Dr. E. M. Howard was instructor.

The Stearns Coal and Lumber Co. was represented by five teams and a team of trapper boys. Mr. R. L. Stearns, president of the company, and Mr. J. E. Butler, general manager, accompanied the teams. The trapper boys, who are the youngest boys employed in the mines, came to the meet in their working clothes, and, to make matters more realistic, smudged their faces. The little fellows, who like to play as much as other small boys, and who gave up their playtime to learn first-aid work, were Noble Stevens, Homer Stevens, Edgar Phillips, George Smith, Carl Fleming, and Dault Boyer. Of course, not being so proficient as men, and no special prize being offered for boys, they should receive prizes from the Red Cross Society, American Mine-Safety Association, and others who believe in encouraging this work. The St. Bernard Coal Co., the Consolidation Coal Co., the Wisconsin Steel Co., Northeast Coal Co., and the W. D. Duncan Coal Co. also entered teams.

The first prize consisted of a silver cup donated by the Goodman Mfg. Co., and $60 in cash donated by the Jeffrey Mfg. Co. Teams from Breaker No. 2, Continental Coal Co., and Team 22, Wisconsin Coal Co., tied for first place. The money was divided, and the cup will be competed for in October by the same teams. Each man received a Red Cross medal, and also an American Mine-Safety Association medal. The Jenkins team No. 10, of the Consolidation Coal Co., won second prize, which was the offering of Johnson & Johnson, and consisted of first-aid cabinet, Woods emergency case, five copies Johnson's First-Aid Manual, one dozen rubber cloth-covered first-aid packets.

The following men made up the Jenkins team: Lester Shrum, captain; Louis Briggs, James Walker, G. W. Rucker, Forest Bice, and Thaddeus Shunk.

Team No. 3, Rim 1, Continental Coal Co., Pineville, won third prize, electric-lamp outfits presented by the Hirsch Electric Mine Lamp Co., and the Draeger Oxygen Apparatus Co. The members of this team were Anderson Manon, Harry W. Fritts, J. Grayson Ponder, Charles McPheron, John Steelton, James Stone, captain. Dr. E. M. Howard, instructor.

Fourth prize, consisting of clocks mounted in cannel coal, presented by The Kentucky Block Cannel Coal Co., was tied for by Carey team, of the Continental Coal Co., and Auxier team 21, of Northeast Coal Co. The clocks were divided between the teams.

On behalf of the State University, President H. S. Barker presented each team with a handsome silk banner. The interest aroused by the first-aid contest was manifest in the large number of spectators, and the prominent men from out-of-town present. As the commencement of a series of contests between state teams, it should have a tendency to help the good work of caring for others in time of accident. Kentucky has fewer fatal coal-mine accidents than any other coal mining state in proportion to the number of men employed. The development of coal mines in this state, especially in the eastern part, is comparatively recent; and as the industry increases in coal output there will be more accidents, consequently it is a wise move to encourage first-aid work, as it is sure to save life, as well as alleviate pain. The main object is, not to win prizes, but to save life, and there is scarcely any doubt but that the losing teams in a contest are as proficient as the winners where life is concerned.

Efficiency Valuation of Fuels

Importance of Other Factors than British Thermal Units and the Fusing Point of Ash

By W. F. Elwood*

CONSUMERS for the past 10 years have been in more or less of a muddle arranging and rearranging specifications upon which to purchase their fuel.

The object of this paper is not to rehash theories, formulas, and opinions, but to give the results obtained by the writer, whose research investigations extended over a period of 18 months. While the object of the investigations was the study of the clinkering of coals, other matters of moment cropped out here and there, so that a number of important facts were observed as well. The results obtained are practical facts (not conclusions drawn from approximations by the use of cones, or theories based on supposition) secured by the aid of accurate instruments designed by the writer for the purpose.

In drawing specifications upon which to purchase fuel, many consumers have one particular element around which they center their argument. Once, boiler tests were made for the purpose of selecting fuel; more recently the British thermal unit has attracted attention, and most recently the argument has been raised, "that in order to be certain of the coal purchased, the consumer should know definitely at just what temperature the ash will fuse, and then shovel the coal into the firebox as before."

It is true that the ability of the individual oxides in the ash to fuse has a certain bearing upon its clinkering; but with reasonable precaution on the part of the fireman, this should cause little concern. It is probable that the tendency of a coal to coke has an influence on its tendency to clinker, but it does not follow that because one coal containing a certain percentage of volatile matter will coke, another coal containing a similar amount of volatile matter will do likewise.

For the sake of comparing different coals and the methods of firing them, use is made of the analyses in the accompanying table.

Coal No. 1, an anthracite, responds well to a forced draft, and, inasmuch as this coal has no tendency to coke, and is firm during combustion, no obstruction of air is to be expected and no clinkering, regardless of the fusibility of the oxides. In case the coal is quite small in size, the firebed thick, and the draft poor, clinkering will take place, provided the fusible oxides are properly proportioned.

No	Name	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur
1	Anthracite	41	6.21	87.06	6.32	.97
2	Bituminous smokeless	1.03	14.60	80.11	4.26	1.17
3	Bituminous steam	1.23	28.50	62.06	8.21	1.45
4	Bituminous gas	1.19	37.00	55.39	6.42	1.09
5	Bituminous gas	3.80	49.00	39.35	7.85	.77

Coal No. 2 represents a so-called smokeless, or low volatile, steam coal, in which there is an increase in volatile matter over that of anthracite; it is a coking coal. In firing with this coal, lighter charges and more of them are needed than with anthracite, in order that no greater volume of gas may be generated from the green charge than the combustion chamber is capable of holding for complete oxidation. This coal will require that the fuel bed be worked often, in order to break open passages in the coked coal, and permit the oxygen to reach the fuel through the proper channels, instead of forcing the highly heated carbon to extract oxygen from the impurities in the coal.

In breaking the coke, the slice bar must not be thrust under the fire, and then used as a lever to lift the bed of coals, for this throws the ashes on top, dampens the fire, and offers the ash an opportunity to clinker. A good method of firing such coal is to place fresh coal in the front of the firebox, where it will partly coke, then just before putting another charge in the furnace, push the partly coked coal so as to spread it over the grate bars uniformly. If this system is not followed, the coked coal in the firebox should be broken by lifting the slice bar and letting it fall here and there.

Coal No. 3 is a high-volatile bituminous steam coal; and coal No. 4 is a bituminous coal considered as a "gas coal," yet both are used for producing gas.

The method to be followed when firing with these coals is to charge the green coal on the hot bed, so the combustion chamber will be able to take care of the gas as soon as evolved.

Coal No. 5 is a non-coking bituminous coal from which the volatile matter is easily expelled, but the coal shows no signs whatever of coking. This bituminous coal differs in its action from other bituminous coals in the firebox.

The complete oxidation of the volatile combustible gases is just as important as the oxidation of the solid combustible material of coal; therefore, where is the economy in charging into the firebox a larger amount of coal, and generating a greater volume of gas than the combustion chamber is capable of burning? It has been maintained by some engineers that these unburned gases carry heat to the boiler; but why not complete the oxidation, and then permit the inert gases, which are products of combustion, to perform this service?

To fire small charges, but fire often, is a good plan to follow in dealing with bituminous coals, and particularly so when knowledge concerning the boiler and equipment is lacking.

Many times the writer has selected

*Chemical Engineer, Greensburg, Pa.

one particular firebox, and followed its actions from 3 to 4 hours, and so recorded some surprising facts. It was observed, by placing an anemometer under the bars, that for a time the air followed its proper course, up through the fuel bed; then the blades of the instrument came to a stop, and moved in the opposite direction. Similar conditions have existed, and do exist, in some of the largest boiler plants

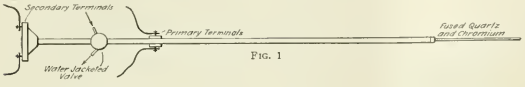


Fig. 1

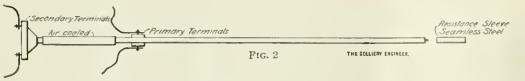


Fig. 2

pretending to have almost perfect combustion systems.

It has been proved that no two boilers will consume the same grade of fuel with identical results, and that no one boiler will consume two fuels of different qualities in the same manner. This being the case, the fireman in charge must adopt methods that will conform to the conditions, and so prevent clinkering. It may not be possible for the fireman to remedy clinkering in every case, for there are boilers in use that were constructed without any serious thought regarding the fuel to be used, and it is in a case of this kind where a fireman is somewhat excusable if results are not as they should be.

The British thermal unit, B. t. u., is $\frac{1}{180}$ of the heat necessary to raise a pound of water from 32° to 212° F.

If the chemical calorimeter is used to determine the British thermal units, almost any result may be obtained, according to the chemical used.

The bomb calorimeter, while accurate in determining the British thermal units in coal, furnishes only a comparison, and does not in the least represent what the coal will accomplish under a boiler; for instance, the action of the boiler toward the coal; the settings of the boiler; the activity of the combustion chamber; the freedom with which the gases pass the baffler, etc., all of which are essentials that the calorimeter does not furnish.

It is true that the tendency of individual oxides in coal to fuse has a certain bearing on its clinkering, but with reasonable precautions on the part of the fireman when this coal is charged should cause little concern.

Some consumers, unless furnished with data showing the fusing points of the ash, would not consider using coal, regardless of what producers may claim and guarantee. Suppose a consumer is furnished with fusing point information, what does it mean to him, and what does he gain from it? All agree that the British thermal units resultant obtained by a calorimeter is nothing more than a comparison, and does not indicate what is to be obtained when the fuel is fired under the boiler. In just the same light is a fusing point determination to be considered; for the reason that the conditions under which the 5 grams of coal ash was fused are not firebox conditions, and it is simply a fusing of an almost perfect ash, and at no time is there experienced an oxidation, a reduction, and a reunion of elements all at the same time.

Many fusing points are determined in such a manner that the consumer would be better off if he had never heard of ash fusing. For instance, when a fusing point is to be determined, a sample of a few grains of coal is selected, burned to an almost perfect ash, shaped into a cone, and placed in a furnace, or muffle, alongside of a number of Seger cones. The heat is raised until the "ash cone" shows signs of fusing, and then the Seger cone, which fuses at the same time, is observed. By referring to a chart, the approximate temperature is noted. Does this procedure come any nearer the solution than does the British thermal unit? Not a bit! This test is made without considering the binder in the cone, with a more perfect ash than what is found in the ash-pit; then there is a web of 5-foot bars between this and the information desired, namely, what is taking place, or should be taking place, in the firebox when the fuel is being transformed into heat. In my investigations, a special set of pyrometers were made, one of a base metal to be used in the stack and ash-pit, and one of rare metal to be used in the fire-bed. These instruments, shown in Figs. 1 and 2, are constructed with check-terminals for the purpose of making corrections due to thermal conditions. Where the temperatures are high and the fire-bed is deep, it is necessary to control this ratio by the use of a steel water jacket, as shown in Fig. 1.

When the test was made, the sampling, the analyses, and the laboratory results were recorded, and as the test proceeded all details were taken into consideration, such as readings from the surface of the fuel-bed down through to the grate bars; drafts, also boiler and weather conditions, and flue-gas analyses were recorded; thus all data concerning the clinkering of the ash were taken under actual working conditions, and in the zone where such changes were taking place.

One of the many tests was made on an Erie fire-tube boiler 125 horsepower, that was hand fired with run-of-mine coal from the Big Pittsburg seam. Omitting analytical details, the fire-bed was worked into a clean condition, then green coal was charged until the bed was from 18 to 20 inches thick. The bed

was then allowed to remain undisturbed until the volatile hydrocarbons were practically all expelled, and the surface showed coking action before conditions were recorded. The hottest point in the bed showed 2,185° F., while clinkers were plentiful. The method of firing was then changed. The bed was worked open; arching from coke was not permitted; charges were small and frequent; and after a reasonable amount of working of the bed, and at practically the same point of volatile hydrocarbon volatilization as was reached in the previous test, conditions were recorded. During this test the hottest point of the bed was 2,420° F., with no appreciable signs of clinkering.

During the first test the method of firing was such that the proper amount of air did not pass through the bed, and this condition, being known, was checked by the use of the instruments. The highly heated carbon could not get sufficient oxygen from the air, therefore took it from the impurities in the coal, this lowering their fusing points, and causing them to form clinkers.

During the second test, with the same firebox and fuel, the oxidizables were given sufficient oxygen through the proper channels; and the impurities were not slagged, hence the result.

Ashless coal would in time meet with the same disapproval as does high-ash coal, for in order to completely oxidize an oxidizable, it must be supported by an unoxidizable until the oxidation of the oxidizable is complete; therefore, ash is not entirely worthless. This argument while true is not advanced, because ash cannot be converted directly into heat.

It has been argued that clinkering is the direct result of the action of sulphur contained in the coal. The writer is not inclined to agree with this, since he knows from experience that coal (waste) containing sulphur to the extent of 12 per cent. and ash to the extent of 33 to 35 per cent. has been fired by hand under boilers carrying 150 pounds of steam pressure with no appreciable amount of clinkering.

Actual boiler testing is the proper practical method for determining the property of a coal to produce steam under any boiler; therefore, in order to determine the actual worth of the coal, a preliminary test should be conducted from which different information concerning the action of the fuel in this particular firebox might be obtained. These results serve as a guide for firing during the final test. In this manner a slight concession by the producer or consumer may work wonders for both.

A coal containing 14,700 British thermal units has no advantage over one containing 13,500 British thermal units, if the former cannot be worked under existing boiler conditions, the surface of the boiler being unable to absorb the heat produced, while the latter furnishes sufficient heat to meet the requirements. A very small percentage of boilers today are being operated by methods and with fuel best suited to them. It is not intended to convey the idea that clinkering always takes place in the firebox which is hand fired. I have had experience with stokers where the coal clinkered to such an extent that the bed would overlap. One reason for this is that the bars were too light to carry the hot fuel, and therefore sagged in spots, this permitting an undisturbed coking of the surface, and obstructed all air passages.

After all, the present confusing specifications upon which coal is purchased (and few really understand) are doomed to be labeled "Experimental," and finally stored away, and forgotten. Less scientific, less confusing, and more simple practical facts must be advanced for the benefit of both producer and consumer. While it would be impossible to proceed far without the scientist, the value of the practical man must not be underestimated in solving these problems. Charging coal systematically and knowingly is one thing; simply shoveling coal into a firebox is another thing.

Closing Exercises of Lehigh Valley Coal Co. Schools

For several years the Lehigh Valley Coal Co. has maintained local schools at Lost Creek, Schuylkill County, and Centralia, Columbia County, Pa., for its employes taking courses in the International Correspondence Schools.

The Lehigh Valley Coal Co. provides the school room, furniture, light, and heat, and competent instructors to help the students over hard places, especially in mathematics. The schools are each divided into two sections, one section meeting on Monday and Thursday evenings and the other on Tuesday and Friday evenings.

After the schools were fairly started, the officials of the Lehigh Valley Coal Co. generously opened the schools to a few employes of other companies and to a few young men who were not employed by any company. They also provided elementary instruction in mathematics for a number of boys and men who were in their employ, but who were not enrolled in the International Correspondence Schools, this being done to get them started so that when they later took courses in the International Correspondence Schools or attended any school they would make better progress.

These schools open in September of each year and close for the summer in June.

The closing exercises at the Lost Creek School were held in St. Mary Magdalen Hall, Lost Creek, on Wednesday evening, June 18. The hall was beautifully decorated with hundreds of roses, beautiful mountain laurel, flags, and streamers. The program was as follows:

1. Instrumental selection, Prof. E. E. Johnson's orchestra.
2. Introductory remarks, Mr. H. J. Heffner, Division Superintendent, Lehigh Valley Coal Co.
3. Annual report of school, Mr. D. T. Glover, Instructor.
4. Vocal solo, Mr. David Jones.
5. Vocal duet, Messrs. Nattress and Taylor.

6. Address, Rev. Father Corcoran, Rector St. Mary Magdalen Church.

7. Whistling solo, Mr. Martin McDonough.

8. Address and presentation of diplomas, Mr. R. J. Foster, Vice-President International Correspondence Schools.

9. Instrumental selection, Prof. E. E. Johnson's orchestra.

10. Address, Edw. J. Flynn, Attorney at Law, Centralia, Pa.

11. Vocal quartette, Cooper Party.

12. Presentation of Michael Lavelle Burke gold medal, Mr. B. S. Daddow.

13. Address, Mr. A. B. Lamb, Mine Inspector, Thirteenth Anthracite District.

14. Instrumental selection, Prof. E. E. Johnson's orchestra.

The graduates on this occasion numbered but two, Messrs. James G. Williams, Complete Coal Mining Course, and Patrick J. Kelly, Electric Lighting Course.

In awarding the Michael Lavelle Burke gold medal, the officials in charge of the schools had great difficulty in arriving at a decision. Mr. Williams's course having been a voluminous one and he having received very high percentages in every lesson, would under ordinary circumstances have won the medal for efficiency in study, but Mr. Kelly was finally awarded it because he had completed two courses with high records, viz., the Short Coal Mining Course in 1910 and the Electric Lighting Course in 1913.

The gold medal, one of which will be presented each year to the student of the Lost Creek school, is a memorial to Michael Lavelle Burke, an estimable young man and a former employe of the Lehigh Valley Coal Co., who died during his last year at college, where he was being educated as a physician and surgeon. It will be provided each year by the E. A. Burke Co., a leading firm of merchants in Shenandoah, composed of older brothers of Michael L. Burke, all of whom were at one time employes of the Lehigh Valley Coal Co. The medal, designed and made by Tiffany, is of irregular circular shape, and is remarkably artistic. The obverse design is a keystone lying on crossed geological hammers and a torch, surmounted by the inscription, "M. L. Burke Medal."

The reverse, which is otherwise plain, bears the engraved inscription relating the cause for the medal and the recipient's name with date.

During the year closed a larger number of students than ever before took advantage of the opportunities presented, and uniformly good progress was made and, although the number of graduates this year was the smallest since the schools started, the progress made by students was greatest, and it is expected that next year the number of graduates will exceed that of any previous year.

The closing exercises of the Centralia School were held in the public High School room, which was also beautifully decorated with flags, bunting, streamers, pennants, and flowers. The exercises were as follows:

1. Selection, Prof. E. E. Johnson's orchestra.

2. Introductory remarks, Mr. H. J. Heffner, Division Superintendent Lehigh Valley Coal Co.

3. Annual report of school, Mr. George R. Wood, Chief Instructor.

4. Vocal solo, Mr. Daniel Walsh.

5. Cornet solo, Mr. Fred Farrow.

6. Whistling solo, Mr. Martin McDonough.

7. Address, Hon. L. S. Walter, Mt. Carmel, Pa.

8. Selection, Prof. E. E. Johnson's orchestra.

9. Mandolin solo, Mr. Robt. Anderson, Jr.

10. Selection, Prof. E. E. Johnson's orchestra.

As at the Lost Creek school, the attendance and work accomplished during the year both exceeded previous records, but none of the students had completed a course, so there were no graduates. Enough, however, are so far advanced that there will be a large number of graduates at the next closing period. In this connection it must be noted that a number of students in both schools passed satisfactory state examinations for mine foreman's and assistant foreman's certificates of competency, though they had not fully completed their courses.

The Coal Mining Institute of America

The Coal Mining Institute of America held its semiannual meeting in Pittsburg, June 18, although the attendance was not as large as usual. The program had two prominent features, the paper by Mr. John W. Boileau and the experiments at the Bureau of Mines.

Mr. Boileau, in his paper on "The Pittsburg Seam of Coal," said:

"In the Pittsburg district proper there is mined more than 60,000,000 tons of coal, and including the Connellsville district, Fayette, and Westmoreland, the coal production amounts to 100,000,000 tons annually, or one-fifth of the entire output of the United States. The coke region will average 21,000,000 tons of coke, or, approximately, 32,000,000 tons of coal, together with a very probable increase in the next 20 years, approximating between 5 per cent. and 7 per cent., if we are to judge by past records. Pittsburg and its adjacent manufacturing establishments in the Monongahela, Ohio, and Allegheny valleys, is the largest coal consuming district in the world. In the Pittsburg district proper, 16,000,000 tons are consumed and enough more in the way of coke to raise the total of coal consumed to more than 25,000,000 tons. More than 12,000,000 tons of the Pittsburg coal goes to the lakes; some of it goes as far west as the Dakotas. In addition to the northern and western shipments, coal goes to tidewater and from there it is carried by boats into New England, coming in competition with coal from Nova Scotia.

"Pennsylvania has only about 5 per cent. of the coal area, but the state is producing about half of the entire tonnage of the United States. This

means early exhaustion, particularly of the gas and coking coals, which will be the fuels of the future. Western Pennsylvania has the best coal for the production of gas and the best coking coal for metallurgical purposes. The Pittsburg seam is rich in by-products and assures the Pittsburg district continuing a great industrial center."

At the Bureau of Mines, various types of breathing apparatus and the mine-rescue telephone were demonstrated, followed by several interesting experiments with safety lamps.

A modern safety lamp was placed in a mixture of air and 8.6 per cent. of Pittsburg natural gas (highest explosive mixture) moving at a rate of 2,500 feet per minute. The flame in the lamp got longer, finally left the wick altogether, going up into the gauze.

A Davy lamp was placed in the same mixture moving at 600 feet per minute, the flame grew brighter, the gauze grew red hot, the flame broke through, and the gas exploded.

A naphtha-burning bonneted lamp and a Davy lamp were each placed in 2-per-cent. gas and both flames became very low.

Two detonator tests were made, using No. 3 and No. 6 detonators fastened to a 20-penny wire nail by copper wire and then exploded, the former bending the nail about $\frac{1}{8}$ of an inch and the latter about $\frac{3}{8}$ of an inch.

In the electrical department of the Bureau, Mr. H. H. Clark showed that a long spark of low amperage and voltage would not ignite an explosive mixture of gas and air, but a high-tension spark would. The former, a big spark, was about 10 amperes and 15 volts, and that is far above the amperage and voltage of a portable electric mine lamp.

Mr. Clark then read a paper on "Portable Electric Mine Lamps," an abstract of which is as follows:

"A most important factor in the usefulness of portable electric lamps is the cost of repairs; another is the trouble that is experienced from interruptions of service due to equipments getting out of order. The principal item of cost is in replacing the lamp bulbs that have been burned out. The lamp bulbs that the Bureau has examined varied in construction and in price from 17 cents up to over 40 cents. The candlepower that bulbs will give is not a fixed quantity, as it varies with the voltage at which the lamps are burned. It is not always a good sign to see a lamp bulb glowing with extreme brilliancy, because it may mean that the lamp is being burned at too high a voltage and may not last but a few hours at the most.

"Another point is the matter of candlepower rating of portable lamps. The true candlepower of the lamp is, of course, the average candlepower that it gives over its illuminating range. Some lamps if measured from a point directly in front of their reflectors will give them from five to ten times the candlepower that they would give if their candlepower were measured from a point 30 degrees on either side. An effect of this sort is, of course, to be expected, but the statement as to how the candlepower is measured should always be made, because two lamps that really give the same amount of light give widely different candlepowers when measured 'head on.'"

Briquets in France

The production of briquets in France increased from 1,729,585 tons in 1911 to 1,793,459 tons in 1912. The department of the Nord showed an increase of nearly 41,000 tons; that of the Pas-de-Calais, 23,000 tons. This output in 1912 is the product of 11 companies.

Rescue Work at British Mines

Organized rescue work is receiving quite as much attention from British mine owners as it is receiving in the United States. There are a number of mine rescue stations in Great Britain, of which the best known are Altofts and Tankersley, in Yorkshire; Howe Bridge, Atherton, Lancastershire; Crumlin, Aberman, Porth and Swansea, in South Wales. In several of these districts a number of mine owners collectively pay the cost of erection and maintenance of the rescue stations, and each colliery in the district sends a number of men who have passed a searching physical examination, and who are members of the St. John's Ambulance Association, to participate in a rescue drill every week. The illustration herewith shows the rescue party of Penrhiwceiber colliery No. 4, equipped for duty with Draeger apparatus and storage-battery electric lamps. This corps is highly efficient, and in addition to their proficiency in rescue work they are each able to pronounce the name of the colliery they represent, which we are inclined to believe is a feat impossible to those of our readers who are not natives of Wales or of Welsh extraction.

Rescue Party at Penrhiwceiber Colliery

Fire Protection of Mines

The Importance of the "Human Element" as Well as Proper Equipment for Guarding Against Mine Fires

*By James Taylor**

NO PROBLEM is more deserving of careful study than the saving of human life, and the impulse is well nigh universal that safety must hold first place.

As one of the state inspectors of mines, the more I investigate the cause of fires, explosions, and other accidents in coal mines, the more it appears to me that the thing to be dreaded is the "human element."

Carelessness and inefficiency find their way into most mines. The wall of caution that naturally surrounds the man who digs coal is torn down completely. The working face of an entry or room is only as safe as the miner employed therein makes it. Hence the surest way to remove the accident is to educate the employes themselves.

We read the usual report "another mine explosion," "another mine fire," etc., that "the mine was in excellent condition," that "it was a model, up-to-date mine," and we shall continue to read the same reports until the human element has been instructed, while working in and about the coal mines, how best to prevent fires and accidents. The best fire protection of mines should be the human element, which at the present time consists of representatives from all nations, only from 30 to 40 per cent. of whom are English speaking. If we are to have fire protection in mines these men must be brought to the efficient standing of skilled mechanics. It is unfortunate that such unskilled labor is gaining a foothold in our coal mines; however, the fact is before us and a remedy is needed.

All mine employes should be instructed as to the dangers, prevention, cause, and the most effective method of fighting mine fires. Mine managers, assistant mine managers, timbermen, and drivers should be drilled in withdrawing the men from mines, and individual miners should receive instruction on the subject. Impress on all underground employes the importance of instantly investigating the slightest indication of fire; a full knowledge of a present danger is the surest safeguard, because such knowledge suggests at once the remedy or at least admonishes caution.

What is lacking most is courage—courage to prevent a coworker from opening a keg of powder with a pick, courage to prevent him from violating the rules of the company, courage to refuse to expose ourselves to needless danger on his account, courage to report the fellow that wilfully places his coworkers in jeopardy, courage to prevent coal loading where the roof is unsafe, courage to advise him to examine the roof and coal face before loading coal, courage to see that his working place is safe and properly and promptly timbered, and courage to fight and not to run away from the first indication of fire underground.

Most men like to shift the blame and condemn the other fellow. When the miner's roof comes down on his back it has killed him perhaps, because he neglected to prop it. Or, he failed to extinguish a burning canvas, and his coworkers lose their lives. Would it be harsher discipline to send him home alive than to regulate matters so that an ambulance is necessary.

The miner may think that it is a small error to leave his props in the cross-cut or along the track when they should be on end supporting the roof.

Every man should know his part in promoting safety, and should be disciplined if he does not do it. Discipline should be of the workman by the workman and for the workman. Discipline should be the mine manager's and miner's main object, and they should urge it and enforce it.

The miner and the operator should learn that it is to their advantage to lessen the losses of the coal industry. The loss of life and limb could be materially reduced by the members of the U. M. W. A. and the Coal Operators' Association of this state cooperating in the enforcement of every reasonable rule for safety and for fire protection. Miners and operators should work as a unit to eliminate the causes of all accidents.

The best fire-protected mines are those at which the operator gives the men a chance to develop, by furnishing them with instructors at a night class that makes safe and good work a matter of discussion. It puts a spirit of craft pride in their hearts. These instructors should be men from the mine who have had practical experience.

Fire protection of mines is secured by the use of the mine telephone. There is a mine telephone law in this state that provides for a party line telephone which includes one telephone on the surface not more than 200 feet from the tipple, and one at the bottom of the hoisting shaft, or in a slope or drift mine at the first cross-entry in operation; and in addition there is to be one telephone at each inside parting. Telephone lines are to be repaired promptly and no mine official should pass these telephones at the inside parting without testing them by communicating with those in charge of the various parting telephones.

There should be a system at each mine requiring the shot firers to report by means of the mine phone the progress of their work to the night engineer as they go through the mine firing the shots. By this means the engineer knows at all times just about where the shot firers are. If the shot firers fail to report from the different stations at a certain time, the engineer knows

*State Inspector of Mines. An address delivered at the Mining Conference held in connection with the dedication of the Mining Laboratories, at the University of Illinois.

that something has gone wrong and he summons help. If the last call of the shot firers was from station No. 4 and they failed to call from station No. 5 at the usual time, the night engineer would be able to give the approximate location of the shot firers, and if they have met with an accident he might be able to save them. Or in case of fire, the shot firers could give the location.

At the present time there are too many bosses, face bosses, etc., to protect the miner against danger when he should and could protect himself against commonplace dangers. No number of bosses will take the place of the miner's own watchfulness. Any man worthy of the name of miner will seek his own safety as well as the safety of his fellows.

In my opinion, one of the best fire protectors at a mine is a reversible fan. In this matter we should be guided by the results obtained in past experience, comparing the lives and property saved and lost where reversible and non-reversible fans were in operation.

At midnight, January 14, 1902, the tower, shaker screen, and building at the Maplewood Coal Co., mine No. 1, located at Farmington, Ill., were on fire. On arriving at the mine the writer found the fire going down the hoisting shaft which was the downcast. No one was in the mine, but there was danger of setting fire to the shaft and the timbers at the bottom, as well as the mule stables containing 12 mules. To prevent this, the fan was reversed, thereby making the hoisting shaft the upcast. We then descended the fan shaft and after seeing that the mules were safe, stationed men at the bottom of the hoisting shaft to extinguish burning timbers of the tower as they fell into the shaft. The fire destroyed both the tower and the dump building, but the shaft and the mules were saved.

December 9, 1904, a fire started on the main intake entry at the Shool Brothers' mine, located at Bartonville, Ill., by a trapper dropping his lighted lamp on a quantity of hay which had been allowed to accumulate at the door he was tending. The fire burned the door, the timbers and all combustible material for a distance of several hundred feet along the main entry. The mine timbers were burning fiercely and the hoisting shaft being the downcast, the air-current (life line) was conveying the smoke and fire toward the working face where 121 men and boys were working. The engineer reversed the fan, thereby reversing the air-current, which prevented the fire and smoke from reaching the men and gave them sufficient time to climb the ladder in the escape shaft. The stairs had not yet been placed in this shaft.

Let us make the "life line" in the mine so that we can use it to advantage whenever the occasion may require.

Not long ago the tipple at Star Coal Co.'s mine No. 1, located at Cuba, was burned owing to the failure of the men to use the fire fighting equipment that had been provided by the company in compliance with the state mining law. The fire originated in a small tool house located near the tipple and tramway. In this tool house was a fire extinguisher, and in the nearby engine house was the necessary hose, and close to the boiler house were two large tanks full of water, with pump connections. The second engineer discovered the fire at 3:30 P. M. and gave the alarm by blowing the whistle (this mine is located 1 mile from town), but failed to use the means provided for fighting fire, with the result that the tipple, engine, and boiler house, and part of the tramway, were destroyed. The fire fighting equipment was in good working order at the time the fire started, but of no service in extinguishing the fire from the fact that the engineer failed to make use of it.

A few weeks previous to this a fire started in a neighboring boiler house. The fireman got excited and failed to use one of the two sets of hose located in the boiler house, and the work of extinguishing the fire was left to the mine manager, who came 1½ miles and secured the hose from the tipple and put out the fire after it had destroyed two sets of hose that the fireman had failed to use.

Dustless Breakers

Another step in the improvement of the physical conditions surrounding their employes has been taken by the Lehigh Valley Coal Co., Wilkes-Barre, Pa. Suction fans to relieve the air of coal dust have been installed in all of their dusty breakers, and are being installed in breakers not classed as dusty. In the new breakers, such as the one at Mineral Spring, where dust is controlled by dampening the coal, no suction fans are used.

The suction fans, which are the result of much experimenting, are from 5 to 14 feet in diameter, and absorb from 10,000 to 100,000 cubic feet of dust-laden air per minute, and cause the fresh air to rush in through the windows.

Immense galvanized iron tubes reach all parts of the breaker where dust is generated, or where employes are gathered. One intake is at the top of the breaker where the coal is dumped after coming from the mine, another is at or near the rolls where the coal is crushed, etc.

The tubes conduct the dust-laden air to the fan which whirls it up into a tower where it is moistened by a spray of water. The rush of air causes the moistened dust to travel past wide, sloping shelves, down that tower and through another that is erected alongside for the purpose, until it finally drops to the ground in a quiescent condition.

With the 14-foot fan at the Dorrance colliery, Wilkes-Barre, the tubes are from 2 to 3 feet in diameter, and the big main tube reaching directly to the fan is at least 7 feet in diameter. The fan runs at an average rate of 130 revolutions per minute.

Steel in Mine Construction

Advantages of the Increased Use of Steel Both Above and Below Ground, and Some New Methods of Application

By Carl Scholtz*

THE tendency for greater safety and the development of larger and longer-lived mines has brought about a change in the character of material used for construction purposes, both above and below ground. Up to a comparatively short time ago, wood was used entirely for the construction of coal tipples, head-frames, and buildings on the surface; the only metal used was for the screens, which were of simple design and usually only provided for one separation. At this time, however, wooden tipples are no longer built, except for very small country mines, and steel and concrete are used almost exclusively for the surface plants.

Fig. 1. View from Bottom of Shaft, Looking Up

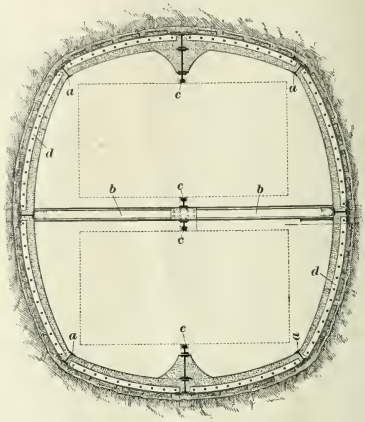


Fig. 2. Cross-Section of Shaft

Steel-tipple construction has undergone a very satisfactory change during the last 10 years; prior to that time the steel tipples were clumsy imitations of the wooden structures, and were built without reference to the strength and proper position for best results. The earlier tipples were much too heavy; usually 12-inch double channel columns, elaborately laced, were used to take the place of 12-inch square timbers, and this made a structure strong enough for a very heavy locomotive, and the corresponding cost prevented extensive adoption of steel tipples. A properly-designed steel tipple is no more expensive than a wooden tipple of equal strength, and has so many advantages that there can be no question of the advisability of the use of steel. The elimination of fire risk alone is of much importance, not only on account of the saving in insurance premiums and possible property loss, but the interruption of operation by fires, which generally occur during the winter months when fires are used in or about tipples, with entailed danger to the mine. Steel tipples furnish the advantage of placing the supports some distance away from the shaft, and the "A" frame type has become very popular, and is extensively used. With a tipple of this design, the wear of the shaft lining does not affect the structure because the supports are some distance from the side of the shaft, and caving would not affect the supporting foundations. Where fireproof shafts are used, the three-leg tipple, which has been exploited by a Chicago engineering firm, can be used advantageously and at a minimum cost. The subject of tipple designs is discussed by another speaker, and no further reference is here made thereto.

Within the last two years the writer developed two new mines, both of which will have a life of approximately 10 years. One was a shaft mine, and was equipped with a steel tower, bolted so that upon extraction of the coal it can be taken down and removed to another location. In its present installation only three tracks were needed for the preparation of the coal, but the tower was built for a four-track tipple, which may be wanted at the

*President of the Coal Valley Mining Co. An address delivered at the dedication of the Mining Laboratories of the University of Illinois, May 9, 1913.

second location. The second mine was a slope, and since it is expected to be the last slope mine which our company will develop, and there would be no further use for the bents, wooden construction was adopted. Thirteen months after this mine began operation, the tipple was destroyed by fire, and the resultant losses would have paid for the steel construction, even though it would have been wasted entirely upon the extraction of the coal at this locality.

The other buildings on the surface, and particularly the boiler and engine houses, must be fireproof, and much steel and iron is used for this purpose, particularly siding, roofing, and roof trusses. The contents of these buildings is nearly all steel and iron.

In underground workings steel is used extensively, and in the point of order the shaft construction will be considered next. Fireproofing of shafts is regarded as important for safety, and many state laws require such construction. In large and important mines a permanent shaft lining is desirable on account of the elimination of interference in operation due to repairs. Steel frames similar in design to wooden sets for 2- and 3-compartment shafts have been installed with steel sheeting as lagging. This construction, however, is very expensive, and has not met with much favor. A modified design of a steel shaft lining has been designed by the author, and installed at shaft No. 1 of the Consolidated Indiana Coal Co., Dallas, Iowa. The arrangement of steel in this design provides for the principal members to be placed vertically instead of horizontally, as is the case with the use of timber. Fig. 2 shows eight I beams *a* are used; four near the outside corners of the cages, two in the center of the cages to which the buntons *b* are fastened, and two on the sides to which the outside guides *c* are fastened; this makes a shaft of elliptical shape. The height of the I beams ultimately forms the thickness of the concrete lining. In sinking, the I beams are fastened together on the outside with curved angle irons *d* bolted to the flange of the I beams. These are spaced about 5 feet apart, and thin lumber lagging is used to prevent the caving of material. When the bottom of the shaft is reached, concrete is put in from the bottom to the top, by clamping short form panels to the inside flange of the upright I beams. These inside forms are made from 3 feet to 5 feet in height, and ordinarily two sets being sufficient to enable constant concreting, they are used alternately. In the Dallas shaft, this wall was made 7 inches in thickness, and the outside lagging was left in place, with openings at intervals to permit the concrete to tie firmly into the rock surrounding the steel frame. The advantage of this steel and concrete combination is that the fabricated steel can be put in with very little expense, and without requiring skilled labor. Sections are bolted together with fish plates, and each section is made self-supporting by having a brace riveted to the outside of the I beam, which rests in the rock or is supported by a shore or prop safely embedded in the shaft wall. By this means not much attention need be given the plumbing of the shaft as it goes down, because the steel frames can be shifted in the proper position just as the concrete is put in. The old method of putting in concrete shafts by the use of wooden forms is complicated, and requires much skilled labor, besides involves delay, because the forms must be very carefully set before the concrete is poured, in order to have the required alinement for guides and buntons. In the Dallas shaft the vertical I beams were made in 15-foot sections, and in soft material a blind ring slightly larger than the completed shaft was used to permit lagging down to the very bottom of the excavation. Whenever the proper depth was reached, and permanent steel frame was installed the temporary rings were removed, and the lagging adjusted itself to the permanent bolts. The weight of material in this construction, including 45-pound steel rails for guides, and ¼-inch reinforcement rods 6 inches apart, is about 165 pounds per foot of shaft, and is less costly than the amount of lumber required for the same strength. In other words, what has been proven in tipple construction also applies to shaft lining. The method of lining a concrete shaft from the top down can be well compared with building chimneys, which are usually started at the bottom instead of being built from the top down. Fig. 1 is a view of the concrete shaft looking from the bottom to the top. The photograph has grossly exaggerated the appearance of the projecting joints where the form lumber was lapped; in reality the shaft is quite smooth on the inside.

In the mine workings proper, much steel is used for various purposes. The oldest and most extensive application are the rails on the haulage ways. Formerly wooden rails were used exclusively, and on the more important roads iron straps were placed on the top to prevent excessive wear from cars, and later, 8-pound and 12-pound iron rails were used; but with the increased weight of cars and motive power, the important entries are now laid with 50-pound and 60-pound steel rails bedded in rock ballast. Steel ties are becoming quite popular, and while at first thought the expense seems prohibitive, considering that a steel tie for a 36-inch gauge costs about 35 cents against a wooden tie costing about 7 or 8 cents, the saving in wages and the reduced number of ties required makes the steel tie more economical than a wooden one under certain conditions. Where the mine bottom is hard, steel ties can be spaced from 4 to 6 feet apart, enabling the base of the rail to rest on the floor, and thus carry the load. The ties principally prevent the spreading of the track. The reduction in height required is important in low veins, and the ability to use steel ties over and over again, with very little cost for recovery, makes

the steel ties more economical than wood.

Steel I beams have been used for many years around shaft bottoms and on partings where wide entries have to be maintained, but the use of specially made steel props and cross-bars is of more recent adoption. Special H sections have been made, and found to be economical under certain conditions. The greater strength of steel results in the use of smaller sizes, which require less excavation for the same finished clearance, and the saving of wages in bolting these sets together, as compared with the costly preparation of timber, brings down the first high cost of the steel frames. The rapidly increasing cost of timber, and the damaging effect of mine air, which results in dry rot, warrants the investigation of these frames in many localities. Practically all of the underground equipment has been changed to steel, including mine cars, which formerly contained much wood. Locomotives have replaced animal power, and there isn't any part of the mine operation into which steel does not enter to a greater or less extent, beginning with the tools with which the coal is brought down, the cars in which it is loaded, the track over which it is hauled, the steel rope by which it is hoisted, and the surface buildings which are used for preparing it; and yet, 20 years hence, we shall see many other uses of steel.

The Stewart "Broken Back" Splint

*By W. Bert Lloyd**

The most important problem of any industry is, without question, the avoidance of accidents, but no matter what precautions are built about the employes, that unknown quantity, the personal factor, is ever finding or making loopholes through which it may invite or cause disaster.

The duties of a first-aid team are therefore second only in importance to the duties of those who are employed to seek out and remedy dangerous conditions.

To obtain the very highest efficiency, a first-aid team must not only be thoroughly instructed and

Fig. 1. Placing the Splints

drilled, but must have suitable equipment with which to meet any exigency. Many a flickering life has been utterly extinguished that could have been revived and restored, had the patient been properly handled in his journey from the scene of the accident to where he received medical aid.

With this idea in mind, Mr. James Stewart, superintendent of the St. L. R. M. & Pac. Co.'s mines at Van Houten, N. Mex., designed and had built the splint that is herewith shown.

While he calls it a broken-back splint, its uses are not confined to this one class of injury. A broken leg, a dislocated hip, a fractured pelvis, a crushed chest, broken ribs or

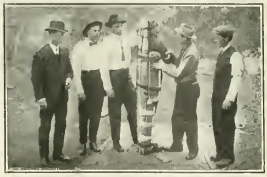


Fig. 2. Completely Protected

broken collar bones, may be handled far more safely, and with greater ease to the patient, with this splint than is possible in cases where but local splints are applied.

One of the most valuable features of this device is the ease with which the patient is placed on the splint; in fact, he is not placed on the splint, but it is placed under him, and as it is being brought into position, the required movement of the patient is almost imperceptible.

Fig. 1 shows the method of placing the splint in position. Fig. 2 shows the patient ready for transportation. It will be seen that his body is thoroughly supported in every part, and that even when the patient is obliged to assume unnatural positions, he still finds adequate support in the splint.

When the two legs of the splint are parallel, there is a space of more than 3 inches between them through which the physician may examine the spine for possible fracture or dislocation before removing the splint. Mr. Stewart is hopeful that his idea may prove of value to those who are seeking better methods of handling injured persons, and that it may be merely a step to something better.

It is my belief that a great help to first-aid work would be gained by offering substantial recognition, in the form of prizes, to those who produce the most valuable improvements in first-aid paraphernalia, the exhibits to be made in conjunction with first-aid contests, and prizes given to only those who are willing to allow their ideas to become public property, barring those who seek or have already obtained patent rights on their ideas.

The alleviation of suffering is the main object of first-aid work, and as this means, in severe cases, the actual saving of life, the awarding of prizes to the most skilful teams is not only a just recognition, but it acts as an incentive to other teams to increase their efficiency. A similar recognition should be made of marked, original improvement in the method or equipment they employ.

The state of Virginia mined 7,846,638 short tons of coal in 1912, valued at $7,518,576, an increase of nearly 1,000,000 tons over the 1911 production.

*Trinidad, Colo.

Answers to Examination Questions

Questions Asked at the Examination for Mine Inspector Held in Pottsville, Pa., May 5 and 6, 1913.

(Concluded from July Issue)

Ques. 19.—What are the provisions of the mine law in regard to fences?

Ans.—The top of each shaft and of each slope (if dangerous) and any intermediate lift, must be securely fenced by a railing or by vertical or flat gates. Likewise, every abandoned slope, shaft, air hole, and drift shall be properly fenced around or across its entrance. Finally, all entrances underground to any places not actually in operation shall be properly fenced across their whole width.

Ques. 20.—Give four rules governing the care, handling, and storing of explosives in the mines, prescribed in the mine law.

Ans.—Explosives shall not be stored in a mine nor shall any workman have at any one time or place more than one keg or box of 25 pounds thereof, unless more is necessary to accomplish a day's work. Explosives shall be kept in a locked wooden, or metallic, box placed at least 10 feet from the track if room is available. In opening a box containing explosives or in handling them, the miner must place his lamp at least 5 feet from the box and in such a position that the air-current cannot carry sparks from the lamp to it; neither shall he go nearer than 5 feet to an open box containing powder, with a lamp, lighted pipe, or anything else containing fire. When high explosives are used, the manner of storing, keeping, moving, charging, firing, or in any way using them shall be in accordance with special rules furnished by the powder manufacturer, which must be indorsed with his official signature and be approved by the owner or operator of the mine or his superintendent.

Ques. 21.—What do you understand the word "ventilation" to cover as applied to anthracite mining in Pennsylvania?

Ans.—The mine law requires that there shall be supplied to each underground worker not less than 200 cubic feet of pure air per minute and as much more as circumstances may require, which shall be so conducted and circulated along the face of each and every working place throughout the mine in such quantities as to dilute, render harmless, and sweep away smoke and noxious or dangerous gases, to such an extent that all working places and traveling roads shall be in a safe and fit state to work and travel therein. From this, it follows that in a broad sense, ventilation has to do with all means, methods, and appliances by which this required quantity of air may be placed in circulation. It is concerned with fans, furnaces, and other appliances by means of which air is placed in circulation; with methods of working in so far as they affect the proper distribution of the air; with instruments for measuring the quantity of air in motion; with brattices, doors, regulators, overcasts, etc., by which the air is kept in its proper course or the quantities of it properly proportioned; with chemistry and physics in so far as they relate to the atmosphere and the gases given off in the mines which contaminate it; and to safety lamps, etc., by which explosions of gas are prevented and its presence detected.

Ques. 22.—What are the principal provisions of the mine law in reference to providing sufficient air for the number of men in each current, and for securing proper control of the different currents?

Ans.—When more than 75 men are employed in any one mine, it must be divided into two or more districts; one district for each 75 men or fraction thereof, and these districts and the air-current ventilating them are known as splits. The material separating the inlet and return currents in each split must be coal or stone if the thickness of the vein will permit, but this dividing pillar may be pierced by cross-cuts or breakthroughs for ventilation, hauling, and drainage. Airways shall be large enough to allow the free passage of not less than 200 cubic feet of air per minute for each person working in the split. In mines generating explosive gas, if gauze safety lamps are used, the velocity of the air must not exceed 450 feet a minute except in the main intake and return.

All permanent stoppings or brattices shall be made of brick or other suitable building material laid in mortar or cement where practicable. Plank stoppings are prohibited except for temporary purposes. Ventilating doors must be hung so as to close automatically and all main doors, unless of a self-acting type approved by the inspector, must be attended constantly by some person to open and close them. Main doors must be in pairs so that one may be closed while the other is open, and an extra main door must be provided and left standing open and out of reach of accident and so arranged that it may be closed at once in event of accident to either or both of the

regular doors. And the framework of these main doors must be substantially secured in brick or stone laid in mortar or cement unless permitted to the contrary in writing by the inspector.

All permanent overcasts shall be substantially built of such material and of such strength as circumstances may require.

Ques. 23.—State the requirements of the mine law in reference to air measurements, with records and reports of the same.

Ans.—The quantity of air in circulation shall be ascertained by an anemometer or other efficient instrument. The measurement shall be made by the inside foreman or his assistant once a week at the intake and return airways, at or near the face of each gangway, and at the nearest cross-heading to the face of inside and outside breasts which are working, and these measurements shall be entered in the report book. A monthly statement of these measurements with the number of persons employed in each district or split shall be sent the inspector before the 12th day of each month. All ventilators must be provided with some device for recording their speed or the ventilating pressure each hour, such data being preserved at the mine for a period of 3 months. Cross-headings must not be more than 60 feet apart.

Ques. 24.—What instruments are necessary or beneficial for a mine inspector to determine the atmospheric condition in a mine? Give name of each and the purpose for which it is used.

Ans.—(1) An anemometer to determine the velocity of the air. (2) A watch to determine the number of seconds during which the anemometer has been registering. (3) A tape to measure the dimensions of the airway where the anemometer was used. (4) A water gauge (customarily in place in each mine) to measure the ventilating pressure. (5) A thermometer to measure the temperature of the air. (6) A barometer to measure the pressure of the air. (7) A good safety lamp to examine the workings for methane. The uses of these instruments have repeatedly been described in these columns within recent months.

Ques. 25.—Name and describe the different gases met with in anthracite mines, giving their symbols, familiar names, specific gravity, where they are found, and their effect upon life and health.

Ans.—Methane; symbol CH_4, also called marsh gas, light carburetted hydrogen, firedamp, or merely gas. Specific gravity, .559. It is found near the roof of flat workings and at the face of rise workings. It is not poisonous but in sufficient quantities causes death by suffocation by diminishing the proper proportion of oxygen in the air. Chiefly dangerous by reason of its explosive properties when mixed with the proper amount of air.

Carbon dioxide; symbol CO_2, also known as carbonic acid, or blackdamp. Specific gravity, 1.529. It is found near the floor of flat workings and at the face of dip workings. It is not poisonous but causes death from suffocation if in sufficient quantity to materially reduce the proportion of oxygen in the air below its normal amount.

Carbon monoxide; symbol CO, also known as carbonic oxide, or whitedamp. Specific gravity, .967. Rarely found in anthracite mines except as a product of combustion from gob fires, from the explosion of certain classes of powder, and in the afterdamp of an explosion. A highly poisonous gas, replacing the oxygen in the blood. It is also explosive.

Hydrogen sulphide; symbol, H_2S, also known as sulphuretted hydrogen or stinkdamp. Specific gravity, 1.191. Found near the floor of flat workings or the face of those going to the dip. It is explosive and is highly poisonous like carbon monoxide.

Hydrogen and ethylene, the latter known as ethene or olefiant gas, are very rarely met in mines. Their symbols are H and C_2H_4 and their specific gravities, .069 and .970, respectively. They are found near the roof of flat workings and at the face of rise workings associated with methane. They are highly explosive but are not poisonous, producing death by suffocation if in large enough quantity.

Nitrogen; symbol N, specific gravity, .971, while always present as the chief constituent of air, is sometimes given off by coal and by the explosion of some types of powder. It is not poisonous but produces death by suffocation by reducing the oxygen content of the air. It will be found near the roof where the ventilation is sluggish.

Oxygen; symbol O, specific gravity 1.106, while common in the air, of which it forms about 20 per cent., is rarely found in a free state in mines. It is not poisonous and is the only supporter of life and combustion.

Ques. 26.—Give approximately and in numerical order the territory embraced in each of the inspection districts covered by this examining board.

Ans.—The mining law recognizes but seven inspection districts as follows: First District, Luzerne County with six inspectors; Second District, the counties of Lackawanna, Sullivan, Susquehanna, and Wayne, with six inspectors; Third District, Carbon County with one inspector; Fourth District, Schuylkill County with four inspectors; Fifth District, Northumberland County with two inspectors; Sixth District, Columbia County with one inspector; Seventh District, Dauphin County with one inspector. The Department of Mines has assigned each of these 21 inspectors a district the boundaries of which are not fixed by law nor do they appear in the reports of the department.

Ques. 27.—In a gangway with 8-foot collar, 12 feet spread and 7 feet clear of rail, we have the following anemometer records: 243, 261, 230, 252, 290, and 224 revolutions at different points in gangway, none of which are in the center, and 320 revolutions in the center of the gangway. (*a*) What is the ratio of the mean velocity to the maximum central velocity of the air-current? (*b*) What is the quantity of air passing per minute?

Ans.—(*a*) Assuming that these readings have been corrected for the instrumental error, the average velocity of the air will be equal to the sum of the individual readings divided by the number thereof, or $1,820 \div 7 = 260$ feet per minute. The ratio of the average to the maximum velocity will be $260 : 320 = 13 : 16 = 1 : 1.231$.

(*b*) The average width of the gangway is $(8+12) \div 2 = 10$ feet, from which the area equals $10 \times 7 = 70$ square feet, and the quantity of air passing equals $70 \times 260 = 18,200$ cubic feet per minute.

Ques. 28.—With a fan developing 30 horsepower at the fan, with a water gauge of 2.3 inches, but from which only 50 per cent. of useful effect is obtained; what quantity of air would be available?

Ans.—As the fan is developing but 50 per cent., or one-half its power in useful work, the net or actual horsepower acting on the air is but 15. Using the formula $q = \frac{tt}{p}$, in which q equals the quantity of air in circulation in cubic feet per minute, u equals the units of work per minute, and p equals the pressure in pounds per square foot, we have

$$q = \frac{u}{p} = \frac{15 \times 33,000}{2.3 \times 5.2}$$

$= 41,388$ cubic feet per minute.

Ques. 29.—Calculate the quantity of air passing per minute, the pressure in pounds per square foot, the water gauge, and horsepower, under the following conditions: Airway 5 ft. $\times$ 8 ft., 4,000 feet long. Anemometer reading equals 200.

Ans.—The quantity of air passing is equal to $5 \times 8 \times 200 = 8,000$ cubic feet of air per minute.

$$\text{The pressure} = p = \frac{k\,s\,v^2}{a}$$

$$= \frac{.0000000217 \times 400 \times 26 \times 200^2}{40}$$

$= 2.257$ lbs.

$$\text{The water gauge} = i = \frac{p}{5.2} = \frac{2.257}{5.2}$$

$= .44$ in.

$$\text{The horsepower} = h = \frac{q\,p}{33,000}$$

$$= \frac{8,000 \times 2.257}{33,000} = .547 \text{ Hp.}$$

Ques. 30.—In a 12-inch column pipe 450 feet long on 42-degree pitch: (*a*) What would be the pressure per square inch at bottom? (*b*) What would be the total weight of water in tons?

Ans.—(*a*) The vertical height of the top of the pipe above its bottom is equal to $450 \times \sin 42° = 450 \times .66913 = 301.11$ feet.

Assuming the weight of a column of water 1 foot high and 1 square inch in area to be .434 pound, the pressure per square inch on the bottom of the pipe will be, $301.11 \times .434 = 130.68$ pounds.

(*b*) The area of the pipe equals $1^2 \times .7854 = .7854$ square feet. The volume of the pipe equals $.7854 \times 450 = 353.43$ cubic feet. Assuming the weight of a cubic foot of water to be 62.4 pounds, the weight of the water in the pipe equals $(353.43 \times 62.4) \div 2,000 = 11.027$ tons.

Ques. 31.—If elected State Mine Inspector and assigned to a district which included a large colliery with which you were entirely unfamiliar, how would you proceed to make your first inspection?

Ans.—The work may be divided into four parts.

(*A*) Before leaving home: (1) Examine the reports of your predecessor in office for information as to the size of the mine, nature and kind of equipment, points he considered worthy of special notice, such as new construction, squeezes, mine fires, existence of bodies of standing water, approach of gangways to abandoned workings or to a property line, and make a note of these and the names and positions of the officials you wish to see. (2) Note if a mine map has been furnished and if it is on the scale and contains the information required by law. Note any points gathered from the map that appear to require explanation or investigation. See if the map has been brought up to date as required by law. (3) Note if the office records contain the necessary reports of air measurements, boiler inspection, steam gauge inspection, etc. (4) Note if there have been any complaints filed against any officials or employes for violation of the mine law and if these have been satisfied or are still pending. (5) Take necessary notebooks, anemometers, tape, etc.

(*B*) At the mine office: (1) Introduce yourself to the clerk and ask for the manager, superintendent, or mine foreman. (2) See if an up-to-date mine map is on file in the office, and get an explanation of any underground or surface features you do not understand. (3) Note if the map shows that the proper pillars are left between adjacent workings or abandoned mines, etc. (4) Inquire as to the number of underground employes and compare this with the air measurements in order to learn if each is receiving the proper amount of air. Note if the foremen, etc., have the proper certificates. (5) Note if the proper air measurements, reports upon abandoned workings, etc., are entered in the right manner in the right books. (6) If, after inspecting the plant, there is reason to believe that any of the boys are below the age at which they are legally permitted to work, inquire for their birth, or age, certificates. (7) See if the proper duplicates of all reports required to be furnished the inspector are on file. (8) If any legal matters are pending concerning alleged violations of the mine law, investigate their status.

(*C*) Before descending the mine: (1) If possible and from some nearby elevation get a general view of the plant. Note if it is neat and tidy or dirty and disorderly. An untidy plant indicates careless and indifferent management which is very apt to be reflected in the manner in which the provisions of the mine law are carried out. At a dirty, neglected looking plant, take nothing for granted but investigate everything. Dirt covers a multitude of defects. (2) Note if a copy or proper abstract of the mine laws and rules is properly posted and is legible. (3) Note if the last report of the State Mine Inspector is properly posted. (4) In all places where young boys are employed see if the list of ages is posted. If any boy appears below legal working age, take his name, and even if his name is on the posted list, investigate

further at the office. (5) Note the number of entrances to the mine, those which are abandoned and which are used for operation or for second openings. Note particularly if the second or escape opening is in first-class condition to be used as an escapeway. Also note that its mouth is at least 150 feet from that of the main shaft, slope, or drift. (6) Note if shaft or slope is provided with gates or fences, that the same are in good order, and that all abandoned openings are securely fenced. (7) See that a speaking tube or telephone is installed for communication between the top and bottom and that the necessary signal bells are in the engine house, and that these are in good working order. (8) Note that the cage is strong and substantially built and is provided with a hood, safety catches, and hand rails, as well as keeps to hold it while unloading, dogs to hold the car in place, etc., or if a gunboat, that it has a shield or protector. (9) Note if the main link on the chain is of iron and the bridle chains are of the proper material and are properly placed. (10) See if the hoisting rope is in good condition and that it has been properly oiled, tarred, or greased. Investigate the safety catches. (11) Note that the shaft or slope has properly working safety blocks to prevent the cars running into it. (12) Watch the top cager, bellman, etc., also the caging, to see that the work is properly done, signals given and answered as they should be, etc. (13) In the engine house watch the hoisting operations to see that the signals are properly given and received. Note that the engineer is constantly on duty and appears competent. See that the hoisting machinery is in general good condition, that the engine house is clean and that oil, waste, or other inflammable material is not scattered around. (14) Note that the hoisting engine is provided with an efficient brake in good working order. (15) See that the drum is provided with flanges or horns to prevent the rope slipping off and that the indicator works properly. (16) See that a properly working steam gauge is within the view of the hoisting engineer. (17) See that the bumpers on the mine cars are of such a width and length that the bodies of the cars are 12 inches apart when they are standing on a level track with bumpers touching. (18) Note that the boilers must be 100 feet (at least) from the breaker unless the same was built before June 2, 1891. (19) See if the boilers have been properly kept up and inquire into the date of the last inspection. (20) Note if there is escaping steam from joints or tubes in the boilers or from piping and learn what has been done to stop it. (21) Examine the working of the safety valves and (if possible) see if they pop at the right gauge pressure. (22) Note if the steam gauge is in good order and the amount of steam carried. (23) Try gauge cocks and note condition of water gauges. (24) Inspect the wash house for convenience to the mine opening and for lighting, heating, water supply, and cleanliness. (25) See if an ambulance and two stretchers of the legal requirements are provided, or if the colliery is so located that the necessity for an ambulance does not exist. (26) Note that the head-frame alone is built over the shaft. (27) Note that the breaker is 200 feet from the shaft or slope mouth and is not connected therewith except by the necessary trestle or approaches. (28) See that there is ample room for loading railroad cars at the breaker without danger of the men being crushed. (29 Note the material of which the breaker is made, particularly for its fireproof qualities. Note if the breaker is clean or dirty, and so liable to fire, and if proper means of escape are provided in case of such fire, and if efficient means are installed for warning men of the existence thereof. (30) See that all breaker machinery is covered or fenced in and that hand or guard rails are placed on all stairs, trestles, etc. (31) Note if the breaker is well lighted and warmed and if the dust is properly removed from it. (32) Note experience and age of breaker engineer and his familiarity with his duties. Note if the breaker hoisting engine is well cared for. (33) Investigate the location and working order of all breaker signals. (34) Note if the fan is well taken care of and that the fan house is clean and that the necessary recording and registering devices are present. (35) Investigate capacity of fan and its ability to supply more than the normal amount of air in an emergency. (36) Study the electrical equipment; note voltage used, insulation, and safety devices. (37) Note the fire fighting equipment, such as the size, location, and number of water mains and plugs, the quantity and the pressure of water available, lengths and condition of hose and the training (if any) received by the men in handling fire. (38) See what rescue equipment is on hand and its condition. Learn if there is a rescue crew and what is the nature and amount of training received by it. (39) Investigate fully all places where men are employed or where there is liability of accident. Learn if the men do their work with the minimum amount of risk to themselves and others and that all proper safety appliances and devices have been installed and are kept in good condition.

(*D*) In the mine: (1) Note whether the signals for dropping the cage are properly given and that it is cautiously lowered, and, while descending, as far as possible, note the condition of the guides, shaft timbering, signal wires or tubes, column pipes and other things suspended in the shaft. (2) If the mine is opened by a slope pitching 15 degrees or less, see that a separate travelingway in good order is provided. (3) Ascertain if the footmen understand their duties, the signaling apparatus is in good order, the cars are properly caged, and if there are bottom shaft gates. (4) Note the handling of men on the cages at quitting time to see if this is legally and properly done. (5) If the mine is opened by a slope, see that there are safety holes at or near its foot. (6) If the shaft is worked from both sides, see that there is the necessary manway around its foot so that men may cross without

passing through the cageways. (7) See that each seam and each lift of each seam is in communication with a second opening, and that this opening is maintained in perfect order for use in an emergency. (8) Note whether all inside structures, such as stables, engine houses, pump rooms, etc., are built of inflammable or non-inflammable material. Note, also, that all hay, lumber, brattice cloth, oil, and other combustile supplies are safely stored, and that no stock of gunpowder is kept underground. (9) Investigate the pumping machinery, see that it is well kept up and of sufficient size to keep the water down. (10) Note whether the medical room is of the proper size, is conveniently placed, is well lighted, ventilated, and cared for, and contains the necessary supplies. (11) Time the haulage motors to see that the speed does not exceed 6 miles an hour and note if an efficient alarm is used on each trip. (12) If steam locomotives are used, note whether enough air is in circulation to maintain a healthy atmosphere. (13) If electric motors are employed see that the trolley wires are so protected that the men cannot come in contact with them. (14) Investigate the working pressure, etc., of compressed-air motors working under high pressure. (15) If gasoline motors are employed see that the combustion is perfect so that noxious gases are not given off by the exhaust. (16) See that the gangways are either wide enough to permit a person safely passing moving cars or that good-size refuge holes are provided on one side of the gangway and not more than 150 feet apart. See that the passageway and safety holes are kept clear of rubbish and dirt. (17) Note whether cars are properly braked or spragged on gravity roads and see that there is at least 2 feet of clear and unobstructed space between the car and the rib. (18) See that the road is drained and the ditches kept open and that the track is well kept up and is clean. (19) Note whether the gangway timbering is in good condition, ample overhead and side clearance is given, and that the ends of chutes, etc., do not project so far beyond the rib as to reduce the 2 feet of clearance required by law. (20) Investigate the nearness of any bodies of standing water to active workings, the location and size of all coal pillars, dams, or the like intended to hold it back, the nearness of the mine being inspected to adjacent mines and the thickness of the barrier pillar, etc. (21) In the breasts and working places, note if the fire boss has left his mark and the dates, if the cross-headings are the legal distance apart, if the air is properly circulated at the face, if they are properly timbered, and if timber is supplied in right quantities, sizes, and lengths, if the powder boxes are of the proper kind and are properly placed and that they do not contain more than the legal amount of powder, if proper tamping bars and needles are at hand. As far as possible note if the men in the place understand their duties. If safety lamps are used, see if they are in good condition. (22) Investigate the number of splits, the number of men employed in each, and the quantity of air supplied. Make the necessary measurements with the anemometer to confirm this. (23) Measure the air-current at the places required by law to determine if the legal minimum is supplied as well as enough more to keep the air pure and the quantity of gas below the explosive limit. See that the velocity does not exceed the allowable maximum in gaseous mines. Particularly investigate each place to see whether it should be worked with a safety lamp or not. (24) Examine the abandoned parts of the mine to see if they are maintained, so far as ventilation is concerned, in the condition required by law. (25) Note whether all permanent stoppings meet the legal requirements. (26) Note the construction of overcasts and undercasts, and see that they are of ample size and do not leak. (27) Investigate the condition of all return air-courses to learn if they are of ample size and are kept clear of falls and other obstructions. (28) See that all doors close automatically, that all main doors have an attendant unless of an approved self-acting type, that they are in pairs, that an extra main door is provided, and that their framework is set in stone or brick. (29) Note the existence of any lamp or fire boss stations, warning or gas boards, etc. (30) Investigate the type of safety lamp used, note method of locking, distributing, cleaning, etc. (31) If the mine is gaseous and portable electric-storage battery lamps are used, note if they are rated as "permissible" by the United States Bureau of Mines. (32) Note if abandoned portions of the mine are properly fenced off. (33) Note if the number of mine foremen and assistants is ample to carry out the provisions of the law, and if they appear competent to perform their duties. (34) Both above and below the ground note if there is a disposition on the part of the operating company, its officials or employes to evade the laws. (35) Make out the necessary reports and forward them to their proper recipients.

Note.—This is a most comprehensive question. The inspector's duties are not confined to investigating mere violation of the statutes, but are extended to include an investigation of every detail whether mentioned in the statutes or not. Hence, the 87 points we have noted as being necessary for investigation by no means cover all the possible ones. However, a first inspection must naturally cover the investigation of many points not necessary on subsequent visits.

American Peat Society

A joint annual meeting of the Canadian and American Peat Societies will be held at Montreal, Canada, on August 18, 19, and 20, 1913. Opportunity will be given members of the societies and their friends to visit the two largest peat-fuel plants on the continent, and see them in full operation, at Farnham and Alfred. A special July number of the Journal of the American Peat Society will be issued at 25 cents per copy. Julius Bordollo, Secretary, Kingsbridge, New York City.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Carbon Monoxide Not a Supporter of Combustion

During the recent discussion in the columns of The Colliery Engineer relative to carbon monoxide as a supporter of combustion, a member of the editorial force wrote to his old preceptor, Dr. Joseph W. Richards, head of the Department of Metallurgy, Lehigh University, to which he replied as follows:

Sir:—Answering your letter of 9th inst. re carbon monoxide as a supporter of combustion, you can put me down as still teaching that that gas does not support combustion.

By supporting combustion I mean, of course, supporting the combustion of the materials ordinarily designated as "combustibles." There are materials like aluminum and magnesium, which will under certain conditions take oxygen away from *CO* gas, but these materials are not what are properly termed "combustibles."

Very sincerely yours,

Jos. W. Richards

Dump Car Wanted

Editor The Colliery Engineer:

Sir:—I would like to inquire if any of your readers have known of the successful use of any particular style of dump cars underground for handling dead work, such as cleaning out aircourses, opening up old entries, removing heavy falls, etc. The matter is one in which there seems to have been no progress made from the earliest days of mining, and as everyone knows it is one of the most expensive items going toward the upkeeping of a modern mine in first-class condition. I would much appreciate the benefit of any experience which any one may have had not only with some style of dump car underground, with an explanation of a method in which the dirt was handled, but also whether they have known of the successful use of any type of mechanical loading machine or road-cleaning device in coal mines.

G. E. Lyman,
Mining Engineer

Glen Carbon, Ill.

Is Carbon Monoxide a Supporter of Combustion?

Editor The Colliery Engineer:

Sir:—With reference to the controversy between The Colliery Engineer and Mr. J. T. Beard relative to whether carbon monoxide is, or is not, a supporter of combustion:

One of the principal characteristics of oxygen is the strong tendency it exhibits to combine chemically with other elements. With most elements it unites directly, especially at elevated temperatures, and in many instances this reaction, or chemical union, is attended by the appearance of light, and always by the evolution of heat. The luminous union of oxygen with another element constitutes the familiar phenomenon of combustion and is the principal source of so-called artificial heat.

The great preponderance of oxygen among the elements, together with its tendency to unite with most other elements with the evolution of heat and light has given rise to the expression that it is a supporter of combustion. The distinction between so-called combustible substances and supporters of combustion is, however, one of mere convenience. In the action taking place between the two substances, one is as much a party to it as the other.

If, for instance, a body of carbon monoxide is confined under pressure in a vessel having a pipe with valve attached, and the free end of the pipe is placed in communication with a body of air or oxygen, upon the valve being opened and the temperature of the gases at the free end of the pipe being sufficiently elevated, the carbon monoxide and oxygen will combine chemically. In this case the oxygen is said to be supporting the combustion of the carbon monoxide. Similarly, if the vessel should contain oxygen and the pipe be placed in communication with an atmosphere of carbon monoxide, in the reaction that occurs the oxygen is really the combustible and the carbon monoxide the supporter of combustion. The above is, in substance, the position taken by Mr. Beard and in my opinion it is a perfectly rational one.

Robert S. Wheatley

Salineville, Ohio, July 7, 1913.

Location of Regulator

Editor The Colliery Engineer:

Sir:—Mr. J. B. Williams asks the question: Where is the best place to place a regulator, at the intake or outlet of a split? My opinion is that a regulator should be placed at the intake end, because it is harder to calculate the size of the opening of a regulator for outlet end, for the volume of air passing has expanded on its way through the mine workings, where it sweeps up coal dust, powder smoke, marsh gas, *CH* given off from the coal, and carbonic acid gas given off by the breath of men and beasts and the burning of lights. All of these agencies help to swell the quantity passing, besides the heat of the mine causes the air volume to expand. For instance, 5,000 cubic feet per minute is passing through a regulator at the intake end of split and it gains 2 per cent. firedamp by the time it reaches the outlet. Then 5,000+2 per cent.=5,100 cubic feet, or a gain of 100 cubic feet in volume per minute. This shows

the outlet must be larger or a regulator at the outlet must be larger than one at the intake; so to simplify the work and avoid unnecessary calculation I would place my regulator at the intake.

Pat. J. Lynch

New Waterford, N. S., Can.

Editor The Colliery Engineer:

Sir:—In reply to the question in the June issue on the location of the regulator, by J. B. Williams, I give my reasons for the location of the regulator as follows:

The regulator is usually placed in the return airway at the end of the district close behind the last working place, in line with the old stoppings. This is the best position, especially when the whole district is working, because it forces the pressure on the stoppings and if there is any leakage there it is from the intake to the return; should any gas escaping from old workings rise to any opening in these stoppings or in the regulator, it encounters a strong current of air which sweeps it away to the main return.

In this position the regulator is less liable to interference for there is no traffic at that point. On the other hand, if a great deal of gas is escaping at the faces, as is sometimes the case, it is preferable to place the regulator in the intake just prior to the first working place, so as to keep the air concentrated and at a fair velocity right through the district and back into the return. In this case the air must not be allowed to circulate freely through the doors along the haulage roads and to course to and fro in the old workings, as sometimes occurs in the robbing of pillars. In that position more pressure is exerted on the doors along the haulage roads, hence, would make it necessary for them to be doubled or made air-tight by means of canvas or other heavy cloth.

The advantage of having the regulator in the intake is, if the district fouls with gas the men can get to the regulator to open it and thus allow more air to pass through to clear that section. It is not advisable to put the regulator at the end of the district close to the junction with the main return. The only advantage of having it there lies in the fact that it reduces the leakage at the stoppings, and that could be overcome by special attention to making the stoppings air-tight.

Should the workings be going to the dip it is sometimes advisable to have the regulator at the end of the district close to the junction with the main return. Should the workings be going to the rise it is generally considered good practice to place it close behind the last working place.

W. Dickinson

Editor The Colliery Engineer:

Sir:—In reply to J. B. Williams' question in the June issue of The Colliery Engineer in regard to location of the regulator, I will say, that the regulator placed in the airway offers a certain resistance to the passage of the air-current, that is, it increases the mine resistance in the part of the mine in which it is placed.

My opinion is, that the regulator to give the best results should be placed where the intake air is taken over the overcasts. Where the return air is thrown over the overcasts the regulator should be placed at the outlet of the split. Or, in other words, the regulator should be kept off the haulage roads where it will not be molested by the opening and shutting of the doors which would cause a variation in the volume of air circulated in that split. The location will depend on the system of ventilation in use, whether the fan be a blowing or an exhaust ventilator. The formula for finding the size of the opening in a regulator that will pass any required quantity of air under a given water gauge is written as follows:

$$a = .00038 \times V \frac{Q}{\sqrt{i}};$$

in which Q = quantity of air required;
i = inches of water gauge;
.00038 = a constant number proved by experiment.

William Bailey

Colliers, W. Va.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Resuscitation, by Dr. Charles. A. Lauffer, Medical Director, Westinghouse Electric and Mfg. Co., East Pittsburg, Pa. This book includes a reprint of a paper on this subject delivered by the author before the Philadelphia Section of the National Electric Light Association. The author, after explaining a number of successful results which have been obtained from employing resuscitation methods on men who were supposedly dead, gives a clear description of the mechanism of respiration. The "Prone Pressure," or Schaefer, method of resuscitation, is described in detail. This book shows the necessity of people being versed in the principles of resuscitation, and how to teach persons to be of assistance to the injured. The book is published by John Wiley & Sons, New York City. Price 50 cents.

Steam Turbines.—The De Laval velocity staged turbine is described in a 108-page book just issued by the DeLaval Steam Turbine Co., Trenton, N. J. It has only a single pressure stage, but multiple velocity stages, that is, the steam is expanded completely from initial pressure to terminal pressure in a single set of nozzles, after which it impinges upon a first row of moving buckets and is then deflected to a row of stationary vanes from which it is again directed upon a second row of moving buckets. A second row of stationary guide vanes and a third row of moving buckets are added in some cases. The book treats of the history, theory and construction of this kind of turbine, showing drawing of the first machine of this kind designed in 1893.

The Properties of Saturated and Superheated Ammonia Vapor, by Prof. G. A. Goodenough and Mr. W. E. Mosher, has been issued as Bulletin No. 66 of the Engineering Experiment Station of the University

of Illinois. It contains two tables of the properties of saturated ammonia and an extensive table showing the properties of superheated ammonia.

The Steam Consumption of Locomotive Engines From the Indicator Diagrams, by J. Paul Clayton, has been issued as Bulletin No. 65 of the Engineering Experiment Station of the University of Illinois. Copies of Bulletins Nos. 65 and 66 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Catskill Water Supply, by Lazarus White, C. E. Published by John Wiley & Sons, New York. 750 pages, illustrated, $6 net.

Much of this book is devoted to methods of construction employed by the contractors. These are of interest to engineers in general, as design and construction go hand in hand. He takes up in detail the History of New York Water Works; The Board of Water Supply; Location of Catskill Aqueduct; Borings and Subsurface Investigations; Explorations for Hudson River Crossing; The Ashokan Dams and Reservoirs; etc. The book covers a wide scope and was written in an atmosphere of daily contact with the directing engineers and contractors.

OBITUARY

BAIRD SNYDER, JR.

Baird Snyder, Jr., mining engineer, successful mine manager, genial friend, and an honorable man in every phase of his character, died on July 9, as a result of an automobile accident.

He was born in Pottsville, Pa., November 21, 1868. On his paternal side he was a grandson of the late George W. Snyder, a pioneer in the development of the coal and iron industry in Schuylkill County, Pa., and on his maternal side he came of the Morris family, prominent in the American War for Independence. In physique, mental acquirements, and character, he combined the best traits of a distinguished ancestry.

His early education was acquired in the public schools of his native town. As a mere boy he entered the service of the Pennsylvania R. R. Co. as a clerk in the freight department. Later he secured a position in the engineering department of the Philadelphia & Reading Coal and Iron Co., and supplemented the

Baird Snyder, Jr.

practical work performed there with reading and study. Naturally of active mentality, he readily absorbed knowledge, and applied it. Besides acquiring technical knowledge, he was a reader of good literature generally, and was a pleasing and interesting conversationalist.

Aside from the short period in the service of the Pennsylvania R. R., his entire business life was connected with the coal mining industry. For some 13 years he was assistant superintendent of the Lehigh Coal and Navigation Co., and assistant manager of the Alliance Coal Co., under the late W. D. Zehner, General Superintendent, whom he succeeded some 6 years ago. He had as general superintendent entire charge of some 15 large collieries in the Southern Anthracite coal field, and his management was remarkably successful. When he resigned some 2 years ago, the Board of Directors of the Lehigh Coal and Navigation Co., as a mark of appreciation of his services, presented him with a set of resolutions expressing regret at his retirement, and a check for $5,000.

At the time of his death he was engaged in developing a large body of coal on the lands of the Girard Estate in the Western Middle coal field, on which he had obtained a lease, and to work which he had organized the Locust Mountain Coal Co.

Mr. Snyder was married about 15 years ago to Miss Jennie Craig, of Audenried, who with two sons, Baird Snyder, III, aged 13 years, and Robert Morris Snyder, aged 5 years, survive him.

Baird Snyder was one of those rare personalities in which were combined force of character, executive ability, positiveness in what he considered right, a keen sense of humor, coupled with a kind and lovable disposition.

CHARLES S. SHINDEL

Charles S. Shindel, of Tamaqua, Pa., President of the East Lehigh Coal Co., and of the Tamaqua Mfg. Co., was instantly killed in an automobile accident on July 8, when his friend and companion, Baird Snyder, Jr., was fatally injured.

Mr. Shindel was born in 1867, a son of Conrad Fry and Mary Louise Shindel. He came of Revolutionary stock, four of his ancestors having been killed in the Wyoming massacre. His early education was acquired at the Wyoming Seminary, Kingston, Pa. For 25 years he was prominent in business affairs in his home town, and was twice elected to the office of Chief Burgess. In 1901, he was appointed Postmaster by President McKinley and held that position for 9 years.

He was a man of kindly disposition and rare business ability. Socially he was extremely popular, not only in his home town, but in all sections of Eastern Pennsylvania, and though he held memberships in numerous clubs and social organizations, he was a man who made social pleasure subservient to business. His widow and two young daughters survive him. In his death, as in that of Baird Snyder, Jr., a man in the prime of life, with apparently years of great usefulness before him, was removed, and his loss is mourned by many friends.

Should Exhaust Steam Be Wasted?

Examples of Installations of Steam Turbines to Utilize Power Ordinarily Wasted in Exhaust

By P. Barrett Coulston*

THE question of the utilization of the properties latent in the steam delivered from the exhaust of a reciprocating engine, has been one of interest and thought to engineers ever since engines were first invented. The adoption of the condenser was a means toward this end; and the special arrangement of valves, under many different patents, another. It is, however, only since the exhaust-steam turbine was perfected that the desired object has been accomplished. The results obtained by the combination of an engine with an exhaust-steam turbine are such that an investigator might be forgiven for questioning their reality when first hearing of them.

It is proposed, first of all, to give some examples of installations and the results obtained, and thereby to demonstrate what it has been possible to obtain; secondly, to consider the means by which such results have been obtained; and thirdly, to discuss broadly some cases which it is considered may be peculiarly applicable to those who are specially interested in engines.

The first example is that of a colliery where non-condensing engines of 1,200 horsepower were installed for winding gear, etc., taking about 36,000 pounds of steam per hour. An exhaust-steam turbine, fitted with electric generator and condensing plant, was then installed, with the following results:

The exhaust steam from the engine which drives the turbine plant gives 1,000 kilowatts, or, say, 1,500 indicated horsepower; the 36,000 pounds of steam which must still be generated now yields 2,700 instead of the original 1,200 indicated horsepower; and the additional power obtained from the electrical set is being used for different purposes throughout the colliery.

*Transactions of the Manchester Geological and Mining Society.

Another example is that of an engine of 1,000 indicated horsepower, which, when condensing, takes 15,000 pounds of steam per hour, and, when non-condensing, gives 900 indicated horsepower for 20,000 pounds of steam per hour. When the engine is non-condensing and the exhaust-steam passes through a supplementary turbine, an additional 940 indicated horsepower is obtained, giving a total output of 1,840 indicated horsepower for 20,000 pounds of steam, or a steam consumption of 10.9 pounds per indicated horsepower-hour, as compared with 15 pounds with the engine alone condensing. When the load demanded from the engine and turbine is reduced to 1,000 indicated horsepower as happens during certain periods, it is obtained from 13,000 pounds of steam per hour; and, moreover, the combination remains more economical than with the engine alone running condensing, until the load falls to between 400 and 500 indicated horsepower.

The comment that the combination of an exhaust-steam turbine with an ordinary reciprocating engine must of necessity make the plant of a highly complex nature, is quite erroneous. It is universally acknowledged by all users of steam turbines that these appliances require considerably less attention than is the case with reciprocating engines. Their upkeep is, at the worst, not greater than that of an ordinary engine, and the question of available space for their erection is one that requires but little attention.

The function of the exhaust-steam turbine lies in the capacity which it evinces to make efficient use of the higher vacuum, for the combination of a steam engine and an exhaust-steam turbine is simply that steam is passed through the engine, in which it does a certain amount of useful work, and then to the turbine, in which its remaining energy is used. It is an axiom that a reciprocating engine cannot be designed of such a nature that under working conditions it would really deal efficiently with the enormous volume of steam at the low pressures which obtain in a condenser; consequently, this steam is exhausted, although containing a large percentage of useful energy.

The simplest combination of engine and turbine is that in which the exhaust steam from the low-pressure cylinder of the engine is fed direct into the steam turbine, during its passage through which the whole of the available energy of the steam is transformed into work; the exhaust of the turbine is then passed into a condenser, giving a high vacuum; and in this way the maximum of power is extracted from the steam. It is not, however, in every case that such straightforward circumstances are to be obtained.

There are three items which stand prominently forward as being beyond dispute, namely, (1) the capital expended in the installation of the exhaust-steam turbine is very low, being only that of the turbine set and its condenser; (2) the space is so small that the plant can almost invariably be installed in the existing engine room; and (3) the pipe connections are very simple.

The chief advantage of the exhaust-steam turbine may be stated to be an increased efficiency, due to either excess power for the same quantity of coal expended, or the same power for less coal. A further advantage is that of the adaptability of the power generated by the turbine set for processes entirely different from that for which the engine was installed, such as electric lighting, the driving of

fans and auxiliary machines, etc., and, furthermore, if the engine is closed down, the work can be done efficiently with the steam turbine by passing live steam through a reducing valve.

The results to be obtained with the exhaust-steam turbine vary, under different circumstances, and the following typical instances may perhaps help to illustrate this.

Taking as an example an engine of 1,000 indicated horsepower; a good engine when working non-condensing will use, say 19 pounds of saturated steam per indicated horsepower-hour and about 16½ pounds of steam superheated to 100° F. per indicated horsepower-hour. For what might be termed a second-rate engine, the figures would be, respectively, 25½ and 22 pounds per indicated horsepower-hour. In normal cases about 15 per cent. of the steam passing through the engine will be condensed by the time that it has been exhausted, so that only 85 per cent. of the steam supplied to the engine is available for use in the turbine.

Case 1. This is an engine using saturated steam at the rate of 19 pounds per indicated horsepower-hour, and the turbine at the rate of 22.5 pounds per indicated horsepower-hour. The steam supplied to the engine is $1,000 \times 19 = 19,000$ pounds per hour; the steam available for the turbine is $19,000 \times .85 = 16,150$ pounds per hour; and the maximum output of the turbine is $\frac{16,150}{22.5} = 717$ indicated horsepower. The output of the combined plant is $1,000 + 717 = 1,717$, and its steam consumption is $\frac{19,000}{1,717} = 11.07$ pounds per indicated horsepower-hour.

Case 2. This is a steam engine with steam superheated to 100° F. The steam supplied to the engine is $1,000 \times 16.5 = 16,500$ pounds per hour; the steam available for the turbine is $16,500 \times .85 = 14,025$ pounds per hour; and the maximum output of turbine is $\frac{14,025}{22.5} = 623$ indicated horsepower. The output of the combined plant is $1,000 + 623 = 1,623$ indicated horsepower, and the steam consumption is $\frac{16,500}{1,623} = 10.2$ pounds per indicated horsepower-hour.

Case 3. This is an engine using saturated steam at the rate of 25.5 pounds per indicated horsepower-hour; and the turbine 22.5 pounds per indicated horsepower-hour. The steam supplied to the engine is $1,000 \times 25.5 = 25,500$ pounds per hour; the steam available for the turbine is $\frac{25,500 \times 85}{100} = 21,675$ pounds per hour; and the maximum output of the turbine is $\frac{21,675}{22.5} = 963$ indicated horsepower. The output of the combined plant is $1,000 + 963 = 1,963$ indicated horsepower; and the steam consumption is $\frac{25,500}{1,963} = 13$ pounds per indicated horsepower-hour.

Case 4. This is the same engine with the steam superheated to 100° F. The steam supplied to the engine is $1,000 \times 22 = 22,000$ pounds per hour; the steam available for the turbine is $\frac{22,000 \times 85}{100} = 18,700$ pounds per hour; and the maximum output of the turbine is $\frac{18,700}{22.5} = 831$ indicated horsepower. The output of the combined plant is $1,000 + 831 = 1,831$ indicated horsepower, and the steam consumption is $\frac{22,000}{1,831} = 12.5$ pounds per indicated horsepower.

The foregoing figures are not from assumed conditions, but are based on results obtained in actual practice, therefore the benefits to be derived from the exhaust-steam turbine are of a highly material nature. In colliery work especially the only possible way in which to utilize the exhaust steam is by means of a turbine.

It may be thought that a serious difficulty is offered in bridging over the time of stoppage of operations during which no steam is supplied to the turbine from the engine. This, however, is not the case, for by the introduction of what is termed a "regenerative thermo-accumulator" it is a simple matter to supply steam to the turbine continuously, although the supply of steam from the engine to the accumulator is of an intermittent nature.

The type of accumulator most generally used is that of a large vessel, or container, filled with water or other material having heat-storing properties. The exhaust steam from the engine is led into this receptacle, and then supplied to the turbine. When the engine is running and supplying more steam than can be used by the turbine for the time being, the surplus is condensed in the accumulator at about atmospheric pressure, and the temperature and pressure of the water or other substance comprising the accumulator rises gradually as more steam is condensed. When the engine stops, a drop in pressure at once occurs. As the steam is being constantly used by the turbine, recuperation takes place, and sufficient steam is supplied to the turbine to bridge over the gap between stopping and starting the engine.

It is generally found that such an arangement is quite ample for ordinary conditions; but, where the stop may be of too long a duration to be bridged by an accumulator of normal size, it is only necessary to fit a reducing valve by which means live steam from the boilers can be automatically supplied to the turbine when the pressure in the accumulator falls below a predetermined figure. In no other case where non-condensing engines of large power are available is there any other method of power at present in sight that can compete with exhaust-steam turbines, in the use of exhaust steam.

The capital cost of the turbine is at least as low as that of any form of prime mover, while from the point of view of running costs all the power recovered is pure gain; for, after passing the steam through the turbine, it becomes condensed, and may be again fed to the boilers.

Practical Talks on Coal Mining

For men who desire information on Coal Mining and related subjects presented in a simple manner

Mechanics of Mining

An Explanation of the Principles Underlying Calculations Relating to Engines, Pumps, and Other Machinery

By R. T. Strohm, M. E. (Continued from July)

THERE are three important rules, or laws, that state the relation between force and motion, and every piece of mining machinery involves the application of one or more of these laws. They are known as Newton's laws of motion and are as follows:

1. Every body continues in a state of rest or of uniform motion in a straight line, unless acted on by some external force that causes a change.

2. Every motion or change of motion is proportional to the force acting and takes place in the direction of the straight line along which the force acts.

3. Every action has an equal and opposite reaction.

The first part of the first law means that a body cannot move itself, and that if it is without motion, or at rest, it will stay in that condition until some outside force acts on it. This is very easily illustrated by the example of a mine car standing on a track. No matter how long the car may be allowed to stand there, it will never move itself. If it is to be moved, some outside force must be employed, such as a push or a pull due to a man, a mule, a locomotive, or a haulage rope. A force inside the car could not cause it to move. For example, if a man stood inside and pushed against the end of the car, there would be no motion of the car.

The second part of the first law means that if a body is moving, it will keep on moving in a straight line and at the same speed, unless some outside force is applied to change these conditions. These points also may be illustrated by the example of a mine car on a track. Suppose that the car is being pushed along the level and that suddenly the pushing force is taken away. The car will not stop instantly, but

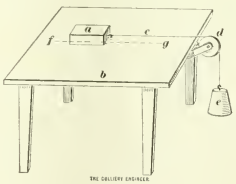


Fig. 28

will keep on moving for a time, although the motion will become slower and slower. The reason for the slowing up and final stopping of the car is that outside forces have been acting on the car. These outside forces are the friction of the wheels on the rails, the roughness of the track, and the friction in the boxes of the axle journals. If there were no friction, and the track were perfectly level and smooth, and the wheels were truly round, the car would keep on moving without any decrease of speed. But the friction sets up forces that oppose the motion of the car and bring it to a stop.

The second law of motion, stated in simple words, means that when a body is moved by a force, the rate of motion depends on amount of the force acting, and that the body acted on will move in a straight line that has the same direction as the force. These points may very easily be shown by a simple experiment: Suppose that a wooden block *a*, Fig. 28, is placed on a flat-topped table *b*, that a cord *c* is attached to it and then passed over a pulley *d*, and that a weight *e* is fastened to the end of the cord. The weight will move downwards and will move the block, and the motion of the block will be along the line *fg*, that is, in the same direction as that in which the pulling force acts on the block. By the time the weight strikes the floor, the block will be moving at a certain speed. Now suppose that the weight *e* is made twice as heavy, and that the experiment is repeated. By the time the weight reaches the floor, the block will be moving at twice the speed it had in the former instance. In other words, by doubling the force that produces motion, the rate of motion in a given distance is also doubled.

The third law of motion means that whenever a force acts on a body, the body reacts equally against the force. This point may be illustrated by Fig. 29, which shows an ordinary support for a steam pipe. The pipe *a* is suspended by a rod *b* from an overhead support *c*. If the section of pipe

weighs 200 pounds, the downward pull on the lower end of the rod is 200 pounds. But the rod pulls upwards with the same force, or 200 pounds. For if it did not pull up just as hard as the pipe pulled down, the downward force would overcome the upward force and the pipe would move downwards; and if the rod pulled upwards with a force of more than 200 pounds, the pipe would be raised. As there is no motion up or down, the forces must be balanced; that is, the action of the load downwards with a force of 200 pounds is opposed by an equal upward pull of 200 pounds by the rod. In the same way, the rod pulls downwards on the beam *c* with a force of 200 pounds, and the beam pulls upwards with an equal force on the rod; and as the two forces are equal and opposite in direction, there is no movement of either the rod or the beam. In each of these cases, therefore, the acting force is opposed by an equal reacting force; that is, action and reaction are equal and opposite.

The matter of action and reaction is involved in the old problem of two men pulling on opposite ends of a rope with a force of 50 pounds each. It is desired to know just what pull the rope resists. At first glance it would seem that a pull of 50 pounds at each end would give a total force of $2 \times 50 = 100$ pounds that the rope would be required to withstand; but this is not the case. The pull on the rope is only 50 pounds, or the same as the pull of each man.

This can easily be proved. As each man pulls with a force of 50 pounds, the action and reaction are equal and there is no motion on the part of either man; that is, each man is stationary, and the effect is the same as though the rope were stretched between fixed posts. Now suppose that one man fastens his end of the rope to a post and steps aside, while the other man pulls with a force of 50 pounds, as before. The pull on the rope will then be 50 pounds. And if the first man now loosens the rope from the post and pulls with a force of 50 pounds, he merely takes the place of the fixed post, and the pull on the rope is only 50 pounds, as it was before.

A wholly different effect is produced, however, if the rope is doubled around the post and both men pull in the same direction. In that case, the total pull on the post is $2 \times 50 = 100$ pounds, because the forces act together instead of opposing each other; and the reaction, or the pull of the post on the ropes, is 100 pounds, because there is no movement, that is, because the action and reaction are balanced.

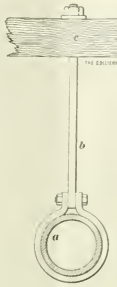


Fig. 29

In the first article of this series it was shown that a force is capable of producing motion and also of destroying motion. A force may have other effects, however. It may change the direction in which a body is moving. For example, take the case shown in Fig. 30 in which a ball *a* lies on the smooth top of the table *b*. Suppose that a push has been given to the ball at *c*, in the direction of the opposite end of the table, so that the ball is rolling along the straight line *cd*. Now suppose that when the ball has reached the position shown, another push is given to it at the side, as shown by the arrow *e*. Before the force of the push *e* acts, the ball is moving in a straight line from *c* toward *d*; but as soon as the force *e* is applied, the direction of motion is changed and the ball rolls off toward the corner *f*, along the straight dotted line. This simple experiment shows how a force can change the direction of motion of a body that is already moving.

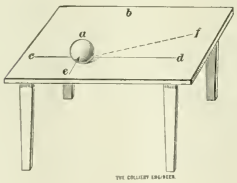


Fig. 30

Furthermore, a force may increase or decrease the rate of motion of a body. As an illustration take the case of a hoisting engine in the operation of raising a loaded cage from a shaft. When the engine starts, the hoisting rope begins to wind on the drum and the pull on the cage increases until it is equal to the total load to be lifted, which includes the weight of the cage, the car, the coal, and the rope. Beyond this point the continued turning of the drum causes the lifting force to become greater than the resistance; that is, the upward pull of the rope becomes greater than the downward pull of the load. Now, it has just been shown that, when two forces are equal and opposite in direction, there is no motion; in the same way, if the two forces are not equal, the larger one will overcome the smaller one and there will be motion in the direction in which the larger force acts. This is what happens in the case of the hoisting engine. As the upward pull becomes greater than the downward pull, the forces are unbalanced, and the cage rises in the direction of action of the larger force.

Suppose that the upward pull is 6,500 pounds and that the load is only 6,000 pounds. Then 6,000 pounds of the upward pull will be used to lift the load of 6,000 pounds and the extra 500 pounds will act to increase the speed at which the load rises. At first the load will move very slowly; but as the hoisting continues the 500 pounds of extra pull acts to make the load

move faster and faster. This increase of speed is called acceleration.

Near the top of the hoist the speed must be decreased gradually until the load comes to a stop at the desired point. This is done by shutting off steam to the engine and applying the brake. As soon as the engine stops its pulling, the downward pull becomes the larger, and this, together with the slowing action of the brake, brings the load quickly to rest. The combined action of the brake and the load thus forms a force that decreases the rate of motion.

It might seem that this last case does not correspond with the law that says that action and reaction are always equal. A little study will show that the law does hold good, however. It is true that the acting force of 6,500 pounds is greater than the direct pull due to the load. But the total reaction, or resistance, is made up of two parts.

One of these is the dead load of 6,000 pounds; and the other is the resistance of the load to being increased in speed. It takes force to make the load move faster, and the force required to give the increased speed is 500 pounds; therefore, the total reaction is 6,500 pounds, or the same as the acting force. The resistance that a body offers to being put in motion is called its inertia; and this inertia or resistance is also met with in stopping a body, because it requires force to stop a moving body as well as to start it or to increase its speed when it is in motion.

(To be Continued)

Mine Ventilation

Method of Conducting Air Through Mines—Legal Requirements of the Different States

THE general method of conducting the air-current through the working places is shown in Fig. 1, which represents the face of a pair of entries in a very gaseous mine. The air comes in through the entry marked intake, which is frequently called the room entry, haulage road, or simply entry, and after passing through the last cross-cut is conveyed back to the fan through the return, which is commonly known as the air-course or back heading. In ordinary bituminous practice the rooms are generally ventilated only by such air as may escape up them from the main current passing along the intake. The mine illustrated being gaseous, a canvas curtain is hung across the intake just in by the first room so that the greater portion of the circulating air is forced up No. 1 room and through the room breakthroughs to the last room, down which it moves to join what current may be passing on the entry. It should be noted that the curtain on the entry is by no means air-tight; it is hung loosely so that more or less air passes by it to ventilate the entry.

Entries.—The number of entries used to develop a property, their width, and height, distance apart, etc., are determined rather by the method of working adopted to mine the coal with the greatest economy (using this word in its broadest meaning of "true" economy), than by the demands for proper ventilation alone. Ventilation is one of the items to be considered in adopting a system of mining and a very important one too, because, aside from the motives of humanity, men cannot work to advantage in poor air. On the other hand, no matter how well the workings are ventilated, if the system of mining is such that the coal cannot be mined and sold at a profit, the plant must shut down and the men be thrown out of work.

At the present time the use of but a single entry from which rooms are turned is either positively and directly prohibited by the laws of the various states, or else these laws are so worded that single entries are prohibited by implication. This means that, although single entries are not prohibited in so many words, they cannot be used if all the provisions of the law are carried out. Thus, if a law says that "entries must be connected with their air-courses by breakthroughs not more than 60 feet apart," it is apparent that there must be two parallel entries relatively close together and parallel or they could not be connected with breakthroughs, and this is equivalent to requiring such parallel entries to be driven.

Probably 90 per cent. of American mines are worked on the "double-entry" system, a section of a mine operated by which is shown in Fig. 1. Of the remaining 10 per cent., a large number are opened upon the "triple-entry" system, and decreasing numbers upon the "quadruple-," "quintuple-," and "sextuple"-entry systems; that is, by three, four, five, or six parallel entries. In addition, a small proportion of this 10 per cent. of the mines are worked by the "long-wall" method.

The distance apart of the parallel entries in the double-entry system varies from 15 to 50, or even more, feet, the two being connected by "breakthroughs" or "cross-cuts" from 50 to 135 feet apart, the distance varying in different states as will be explained beyond.

The width and height of entries is mainly determined by the height of the coal, cost of shooting down or brushing roof, requirements of haulage, timbering, etc. In America, entries are very rarely less than 8 feet or more than 10 feet wide. Few entries are driven less than 5 feet in height even in very low seams, and in thick coal they are commonly of the height of the seam. Thus, the size of entries will vary from say a minimum of 8 ft. $\times$ 5 ft. (area, 40 square feet) in thin seams, to 10 ft. $\times$10 ft. (100 square feet area) in the thick seams. Probably the average haulage entry used in the United States is not far from 10 feet wide and 5 feet high with an area of 50 square feet.

The back entry, return, or simply

air-course, should be of the same or slightly greater dimensions than the intake or entry proper, but such is rarely the case except in thick seams or where the management is good. In thin seams, in order to avoid the cost of brushing, the return is often only the height of the coal, say 3 or 4 feet, and has an area of 30 or 40 square feet as opposed to an average one of 50 square feet for the intake. In some cases, also to save brushing as well as the cost of narrow work, the return is made of room width, say 16 to 20 feet wide, and in this way the average area of 50 square feet may be had. But the principal reason why the return, even in thick seams, is not as large as the intake, is due to the fact that it is rarely inspected and sooner or later is choked to a greater or less degree by falls of draw slate which are not cleaned up because of the expense. Most of our readers will recall instances in their own experience of mines in thick coal where the returns, blocked by falls of slate, have only half the area of the entries, not in one place, but in many.

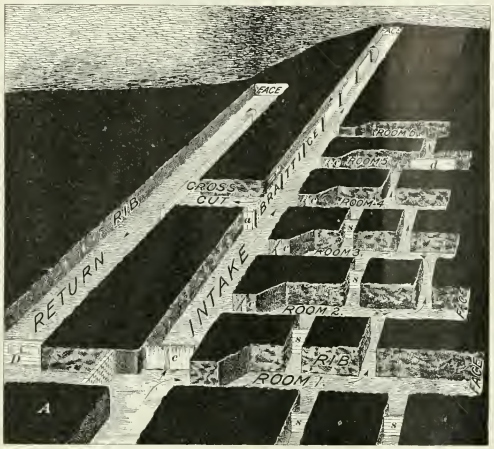


Fig. 1. How a Mine Is Ventilated

Breakthroughs or Cross-Cuts.—The distance apart of breakthroughs, or cross-cuts, is a matter of prime importance in insuring that a proper amount of fresh and pure air is carried to each working place, and is the subject of legislation in most states; the spacing of cross-cuts being fixed by statute, although some latitude is allowed the state mine inspector in determining the distance apart in gaseous mines.

The following will show how the practice varies in some of the states: In Virginia, "breakthroughs for air shall be made not to exceed 80 feet apart in pillars, or brattices shall be used to properly ventilate the faces, etc."; in Wyoming, "no working place shall be driven more than 50 feet in advance of a breakthrough or airway"; in Ohio, "breakthroughs shall be made between main entries where there are no rooms worked, not more than 100 feet apart"; where rooms are worked, "not exceeding 60 feet apart." "Where there is a solid block of coal on one side of a room, —— not to exceed 60 feet apart." When rooms occur in groups (as is the ordinary practice), the breakthroughs are 80 feet apart on each side and are staggered so that the opening in one pillar is midway between the openings in the opposite pillar. In Alabama, "breakthroughs (shall) be made in all room pillars at such distance apart as, in the judgment of the mine inspector, may be deemed requisite, but said breakthroughs shall not be more than 70 feet apart." In West Virginia the regulations are the same as in Virginia. In the Pennsylvania bituminous districts "the mine foreman shall see that proper cut-throughs are made in all the room pillars, at such distances apart as in the judgment of inspector may be deemed requisite, not more than 35 nor less than 16 yards each, for the purpose of ventilation."

It is generally understood that the "distance apart" of breakthroughs does not mean from "center to center"; that is, from the center of one opening to the center of the next; but means from the inby edge of one to the outby edge of the other. Thus, if the breakthroughs are 10 feet wide and are spaced 50 feet apart from inby to outby edges they will be $50+10=60$ feet apart, "center to center." The width of breakthroughs is not defined in any statute, and advantage is sometimes wrongfully taken of this to make them narrower than they should be. Narrow breakthroughs between rooms are perfectly allowable in non-gaseous mines where only a relatively small portion of the air-current is required at the face to clear away powder smoke; but in gaseous mines, where all of the air or a very large part of it is carried around the room faces, the breakthroughs should be of heading (entry) width in order to reduce the friction caused by carrying large volumes of air through narrow openings, and to prevent undue and consequently dangerous velocities thereof. In thick seams the room breakthroughs are very frequently driven in the bottom bench only, and are but one-half or one-third the height of the coal. Where the pillars are thin, the breakthrough is sometimes of the height of a mining only, say, about 18 inches, and is in reality a mining made with a pick, but of a sufficient depth to extend through the pillar.

The abstracts from the state laws given show that much is left to the judgment of the inspector; and this is as it should be, because hardly any two mines are exactly alike in their requirements. Wyoming has a hard-and-fast rule requiring cut-throughs to be not more than 50 feet apart, whereas in the bituminous districts of Pennsylvania, the distance may vary within very wide limits, from 48 to 105 feet. As breakthroughs, being narrow work, are paid for at an advanced mining price, it is a hardship upon the company to expect them to be driven more often than necessary; on the other hand, regardless of cost, they should be driven sufficiently close together to insure the safety and health of the men. The inspector, being a state official and impartial, is the best judge to decide what is the right spacing, and is not influenced by ideas of false economy on the part of the company or unreasonable demands on the part of the men.

(To be Continued)

Electricity in Mines

Classification of Voltaic Cells—Open Circuit Cells—Dry Cells—Closed Circuit Cells—Construction and Care

By H. S. Webb, M. S. *(Continued from July)*

FOR practical purposes, voltaic cells, which are also called primary cells, may be roughly divided into two general classes: Those capable of furnishing a reasonably uniform current for quite a long time and those capable of supplying a current only intermittently, and then only for a few seconds each time, but are able to stand for long intervals on open circuit without deterioration. The former are called closed-circuit cells, and the latter open-circuit cells. Some closed-circuit cells may be used on circuits that are open the greater part of the time—but open-circuit cells should never be used where a continuous current is required—that is, on circuits that are closed the greater part of the time. Most closed-circuit cells deteriorate if left on open circuit too much of the time, hence, they are not suitable for intermittent work, where only small currents are required and the inactive periods are long. For intermittent work, where the idle periods are sufficiently long and frequent to allow the cells time to recuperate, for instance, for electric bells and some types of telephones that are not in constant use, nor in use for long periods at any one time, good open-circuit cells are the most satisfactory.

Open-Circuit Cells.—The Leclanche and dry cells are the most extensively used open-circuit cells. Fig. 9 shows a common form of this cell. A porous cup *p* contains a rectangular stick of carbon, one end *c* of which

Fig. 9

projects above the cup and has a binding post *b* permanently secured to it. The space around the carbon element and within the porous cup is filled with pulverized manganese dioxide. The manganese dioxide, a black substance consisting of manganese and oxygen, is the depolarizing material. It gives up oxygen which unites with the hydrogen gas as fast as the latter is formed, thereby preventing the collection of hydrogen on the carbon element, and thus reduces the polarizing action that would otherwise be present. Outside of the porous cup is the zinc rod *z* with a binding post *b* at its top end. A solution of sal ammoniac is poured in the glass vessel until it is nearly full. This solution can readily pass through the porous cup whose object is to keep the manganese dioxide around the carbon element. *b* is the positive terminal and b_1 the negative terminal of the cell. The top of the glass jar is coated with paraffin to prevent the creeping of the solution, from which the water would then evaporate and consequently cause the formation of a white substance over the top of the jar. This damp white substance is a fairly good conductor of electricity and would therefore allow some of the electricity to leak away besides soon making the place around the cells dirty and disagreeable.

There is enough manganese dioxide in the cup to last while about five or six zinc rods are consumed. The sal ammoniac solution should last about as long as two zinc rods, although it may be necessary frequently to add pure water to replace the water that evaporates. It is usual to seal the carbon and depolarizer in the porous cup by some wax-like compound, leaving small holes for the escape of any gas that may not be absorbed by the depolarizer. This sealing necessitates the entire renewal of the porous cup, with contents, when the depolarizer is exhausted. Sometimes the depolarizer and carbon are held with a bag of porous cloth and sometimes the depolarizer is pressed into cakes under great pressure and one held on each side of the carbon element by stout rubber bands. These cells are made in many different ways and there is much modification in the quantity, shape, and kind of materials used. In some, no depolarizer is used, instead, the surface of the carbon is made as large as possible, so that the quantity of gas that may be formed on a square inch of its surface is so small as to cause but little polarization. Such cells may last longer, but are not apt to give as strong a current, especially if used a little too long at one time, as those having a deppolarizer.

The electromotive force of the Leclanche type of cell is about 1.4 to 1.6 volts, and their internal resistance varies from .4 to 4 ohms.

The best strength of solution for a Leclanche cell is made by dissolv-

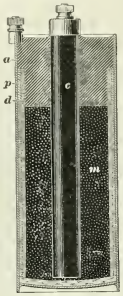


Fig. 10

ing 3 ounces of sal ammoniac, also called ammonium chloride, in a pint of pure water. The ordinary size cells require from 4 to 6 ounces in enough water to fill the jar to within about an inch of the top of the porous cup. There should never be undissolved salts or crystals, or dirt of any kind in the bottom of the cell; remove the salts by dissolving in warm water or scraping them off. The jars usually have printed directions pasted upon them for setting up the cells and marks upon the jar show how much water is required. It may require 10 to 12 hours after setting up the cell before it is in good working order. This time may be shortened by pouring some of the sal-ammoniac solution through the vent holes in the top of the porous cup, then wiping the top dry. To recharge a Leclanche cell, throw away the old solution, wash off and if necessary, scrape clean the various parts. Use fresh solution of sal ammoniac and a new zinc if the old is nearly consumed. If the coating around the top of the jar has been partly removed, replace it by dipping the top of the glass jar into a pan of melted paraffin for a moment. Never short-circuit open-circuit cells with a wire connected across the cell terminals.

Dry Cells.—A section through a dry cell is shown in Fig. 10. A dry cell is one in which the electrolyte is carried in the pores of some absorbent material *p*, so that the cell may be placed in any position without spilling any liquid. However, it is best to stand the cell upright. In dry cells, the zinc element forms a cylindrical can in the center of which is the carbon, surrounded by the depolarizing material. All space not otherwise occupied is filled with some absorbent material, the whole interior is saturated with the electrolyte and the top sealed as tight as possible with some resinous compound. The zinc can is covered with pasteboard to insulate it. These cells behave just like the wet Leclanche cells, except that when exhausted they must be replaced with new cells; they cannot be restored by the addition of fresh materials, like wet cells. A little additional life can be secured from dry cells by punching or drilling holes in the side and standing each cell in a separate jar containing a strong solution of sal ammoniac in water. This hardly pays, however; generally they should be thrown away when no longer able to perform their usual work and new dry cells secured. Dry cells should not be kept any longer than necessary before being used; they deteriorate some, even if not used, and should never be over 6 to 12 months old before being put into service. Most dry cells are made in one standard size, 6 in. $\times$ $2\frac{1}{2}$ in., and have an internal resistance of about .1 ohm. For special purposes larger and smaller cells are made. The electromotive force of all sizes is about 1.6 volts.

Dealers often attempt to prove the superiority of the dry cell they sell by showing the large current it will give when a small ammeter is connected across its terminals. This will show the ability of the cell when new to give a large current through a small external resistance, and a bad cell will be shown up by such a test, but it is not a conclusive proof of the ability of the cell to produce a normal current for a long time. It is harmful to the cell to connect an ammeter directly across its terminals, except for a very brief interval of time.

Closed-Circuit Cells.—A closed-circuit type of cell used for some signal- or warning-bell work is the Edison BSCO cell, which is simply the trade name given to the cell by makers. This cell is shown in Fig. 11. The solution in this cell is caustic soda and its surface is covered with oil to prevent the air from chemically acting upon the electrolyte. One element is a copper frame holding a plate of copper oxide; on each side of this central element are two zinc plates connected together to form one element. The materials for the different sizes of these cells are so proportioned that all become exhausted when holes are eaten through the lower parts of the zinc plates. Then the solution, oil, zinc, and copper-oxide plates are all discarded and replaced with similar fresh materials, which should be purchased from the makers of the cells.

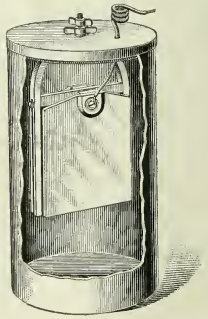


Fig. 11

The proper amount of material is put up in a package for each size of cell. Directions for setting up and caring for the cells come with the cell and with the materials for recharging. Each size of cell may be connected in a permanently closed circuit of proper resistance to make the cell give its normal current until the materials are used up. That is,

these closed-circuit cells do not require the opening of the circuit at all to allow them to recuperate, like Leclanche and other open-circuit cells. The difference of potential across the terminals of the cell when it is in use, is from about .5 to .7 volt. The voltage is rather low, but the internal resistance is also low, and these cells will give a much stronger current than the Leclanche or dry cell.

(To be Continued)

Acetylene Lamps in Coal Mines

Tests of Carbide Lamps and Oil Lamps to Show Their Behavior in Atmospheres Containing Carbon Dioxide

IN VIEW of numerous controversies regarding the action of acetylene mine lamps in mine atmospheres containing blackdamp, and the nature of the products of combustion due to the burning of an acetylene flame, a series of tests were made on July 8, in The Colliery Engineer's laboratory, by H. M. Menner, A. C., assisted by William Z. Price, E. M., Assistant Editor. The tests were made to determine the relative safety of acetylene lamps and the ordinary oil or open miners' lamps.

In the tests pure carbon dioxide (CO_2) was used. As is well known, blackdamp, as found in the mines is not pure CO_2, but it is a gas left after the partial or complete removal of the oxygen from the air. Table 1, taken from a paper on "The Examination and Physiological Action of Pathogenic Mine Atmospheres, with Considerations Governing the Use of Breathing Apparatus," by Edwin M. Chance, former Chief Chemist of the Philadelphia & Reading Coal and Iron Co., and now a Consulting Chemist with laboratory at Wilkes-Barre, Pa., shows the composition of various samples of blackdamp. This paper was read before the Franklin Institute, and is published in the Journal of that institute for November, 1911.

As will be seen from the table, the percentage of CO_2 in blackdamp is comparatively low. Owing to the facts that samples of blackdamp as found in the mines were not available, and that the action of the flame of either lamp is subject to the decrease of the oxygen in the air, carbon dioxide was used in these tests, as its presence in an atmosphere in any percentage results in a relative decrease in the oxygen.

As a chamber in which to test the lamps, a bell jar 10 inches inside diameter and 7¾ inches high was used. This jar held 9,700 cubic centimeters of water, equivalent to 591.9 cubic inches.

In the CO_2 tests the jar was placed with opening up, and after the lamps and various percentages of carbon dioxide were placed therein, the opening was closed with a glass plate.

In an atmosphere of air and carbon dioxide, the latter being 40 per cent. of the total volume, the acetylene flame was immediately extinguished. In this atmosphere the percentage of oxygen (20.8 per cent. of O_2) or 12.48 per cent. was insufficient to support combustion.

In a similar mixture with 33⅓ per cent. of CO_2, a mixture in which there was 13.86 per cent. oxygen, the acetylene lamp burned 2 seconds.

In a mixture of 25 per cent. of CO_2, containing 15.6 per cent. of oxygen, the acetylene lamp burned 3 minutes.

In a mixture with 10 per cent. of CO_2, containing 18.72 per cent. of oxygen, the same lamp burned 5 minutes 31 seconds.

In a mixture with 5 per cent. of CO_2 and 19.76 per cent. of oxygen, the same lamp was extinguished in 7 minutes 29 seconds.

In pure air in a similar air-tight jar, the acetylene lamp burned 10 minutes and 24 seconds, before the flame died out through lack of oxygen.

In determining the amount of oxygen available to support combustion in the various mixtures, the percentage was calculated by taking 20.8 per cent. of the volume of pure air in each mixture. The acetylene lamp used was a "Baldwin Carbide Pit Lamp, No. 32."

In all cases when the lamp was burned in mixtures of air and CO_2, the white acetylene flame assumed a marked yellow color. After about half the time before extinguishment elapsed the flame lengthened, the tip curving upward; and just before dying out, the flame left the burner for a distance of about 4 inches.

When the ordinary miner's oil lamp was used it went out instantaneously in 40 per cent. and 33⅓ per cent. mixtures. In other words, the oxygen available for supporting combustion was 12.48 per cent. and 13.86 per cent., respectively. In a mixture containing 20 per cent. CO_2, or with an available oxygen percentage of 16.64 per cent. the flame was extinguished in half a second. The same result was noted when the mixture contained 18 per cent. CO_2, and an available oxygen supply of 17.06 per cent.

In a mixture containing 15 per cent. CO_2, available oxygen 17.68

Table 1. Composition of Blackdamp

	O	*N*	CO_2	CH_4	Air	Blackdamp	Firedamp
1. Podmore Hall Colliery, stopping in No. 4 Pit	1.45	82.56	10.64	5.35	6.94	87.71	5.35
2. Same, two months later	.72	80.78	11.03	7.47	3.44	89.09	7.47
3.	10.09	89.38	.05	.48	48.23	91.29	.48
4.	5.08	91.81	2.92	.19	24.30	75.51	.19
5.	.90	93.01	3.05	3.04	4.33	92.63	3.04
6.	trace	94.79	2.68	2.53	trace	97.47	2.53

Analyses 1 and 2 were taken from "Blackdamp" by Haldane and Atkinson, Trans. Inst. Eng., Vol. 8, p. 551. Analyses 3, 4, 5, and 6 are taken from the author's experience and are representative of blackdamp from anthracite mines.

per cent., the flame was extinguished in 6¼ seconds. In a mixture containing 10 per cent. CO_2, available oxygen 18.72 per cent., the lamp was extinguished in 14½ seconds.

In a mixture of 5 per cent. CO_2, available oxygen 19.76 per cent., the lamp burned 32 seconds.

In pure air in a similar air-tight vessel the ordinary miner's lamp burned 44.5 seconds.

In all cases where the lamp was burned in mixtures of CO_2 and air, the flame remained constant for a short time, and then immediately shrank until it died out at the wick.

The results given above are simply comparative and must be used in a relative manner, for it is obvious that with a smaller flame or greater volume of the mixture the results will differ from those obtained. But, in all the tests the flames were maintained as nearly constant as possible. The timing was accurately recorded by a split-second stop-watch.

These tests proved that when the amount of available oxygen in the air is below 14 per cent. the acetylene flame is immediately extinguished, and that when the available oxygen is less than 17 per cent. the flame of the ordinary open oil lamp is extinguished.

Tests recently made by Mr. Edwin M. Chance, Consulting Chemist, of Wilkes-Barre, Pa., using actual blackdamp from the mines, showed that the acetylene flame became yellow, and was extinguished when the available oxygen was between 13 and 14 per cent., and that the ordinary miner's open oil lamp was extinguished when the percentage of available oxygen was between 16.5 and 17.5 per cent. These results obtained by Mr. Chance in entirely separate tests and conducted somewhat differently corroborate the figures of Messrs. Menner and Price.

In Miner's Circular No. 4, by James W. Paul, issued by the United States Bureau of Mines, the author states that when the proportion of oxygen in the air available for respiration is as low as 14 per cent., a man "begins to breathe with effort, his head aches and he feels dizzy, and he may have pains in the chest. Air that contains only 10 per cent. of oxygen is extremely dangerous, for it will quickly suffocate any one breathing it."

As an atmosphere containing as low as 14 per cent. oxygen gives physical warning of danger to a man, and an acetylene lamp flame is extinguished in 2 seconds in such a mixture, it is evident that the acetylene lamp is a more positive detector of danger than the ordinary open oil lamp, the flame of which lamp will soon teach its users that it is time to retire to purer air before or immediately at the time the acetylene flame is extinguished, because they will have the physical discomforts described by Mr. Paul as additional warning.

In his experiments Mr. Chance noted, as did Messrs. Menner and Price, that when the normal percentage of oxygen was decreased the acetylene lamp gave a yellow, instead of a white flame. When these facts are considered, it is evident that the acetylene lamp is not

Table 2. Tabulated Results of Tests

Type of Lamp	CO_2 Present Per Cent.	Number of Tests	Duration of Steady Flame	Flame Extinguished
Acetylene	40	1		Instantaneously
		2		Instantaneously
		3		Instantaneously
Acetylene	33⅓	1	1 sec.	2 sec.
		2	.5 sec.	2 sec.
		3	1 sec.	2 sec.
Acetylene	25	1	2 min. 50 sec.	3 min. 10 sec.
		2	2 min. 30 sec.	2 min. 50 sec.
		3	2 min. 45 sec.	3 min. 3 sec.
Oil	25	1		Instantaneously
		2		Instantaneously
Oil	20	1		Instantaneously
		2		1 sec.
Oil	18	1		Instantaneously
		2		Instantaneously
Oil	15	1	2.0 sec.	5.5 sec.
		2	2.5 sec.	7.0 sec.
		3	2.0 sec.	6.2 sec.
Acetylene	10	1	5 min. 15 sec.	5 min. 31 sec.
		2	5 min. 5 sec.	5 min. 29 sec.
		3	5 min. 12 sec.	5 min. 31.5 sec.
Oil	10	1	8 sec.	14.5 sec.
		2	7 sec.	14.0 sec.
		3	9 sec.	13.0 sec.
Acetylene	5	1	7 min. 30 sec.	7 min. 58 sec.
		2	6 min. 50 sec.	7 min. 1 sec.
		3	7 min. 20 sec.	7 min. 30 sec.
Oil	5	1	20 sec.	31 sec.
		2	24 sec.	33 sec.
		3	27 sec.	32 sec.
Acetylene	0 (or pure air)	1	10 min.	10 min. 20 sec.
		2	9 min. 50 sec.	10 min. 28 sec.
Oil	0 (or pure air)	1	35 sec.	43 sec.
		2	40 sec.	46 sec.

expires when the oxygen available falls to 17 per cent.

Many miners know from experience, that the flame of an ordinary miner's oil lamp will be extinguished in an atmosphere, which while deficient in oxygen is not so lacking in the life giving gas, as to be immediately dangerous, and they take chances that frequently result fatally, by continuing in the mixture too long, or by going deeper into it where the lack of oxygen causes immediate collapse.

Experience with the acetylene an unsafe lamp for mines where open lights are used, and that it is a better detector of blackdamp than the ordinary miner's oil lamp. As a detector of blackdamp, it shows by the changed color of the flame, the presence of such quantities as are not discernible by the flame of the ordinary lamp, and if the user immediately withdraws to purer air when the flame goes out, he will suffer no worse result than a headache.

As to the relative products of combustion of acetylene lamps and

ordinary miner's oil lamps, tests made in an air-tight jar with a capacity of 854 cubic inches showed the following results:

Acetylene Lamp

	Per Cent.
CO_2	4.8
O	14.8
C_2H_2	1.4
N	79.0

This mixture had an acetylene odor due to the lamp generating acetylene gas after becoming extinguished, and this acetylene gas (C_2H_2) formed 1.4 per cent. of the products of combustion. If apparatus had been available for stopping the inflow of C_2H_2 after the flame died out, the products of combustion would have been identical with those of the ordinary miner's oil lamp, which were as follows:

Oil Lamp

	Per Cent.
CO_2	4.5
O	14.5
CO	.0
N	81.0

All the results given above are the average of numerous tests made. A tabulated statement of all the tests is given in Table 2.

As the acetylene lamp burned in an air-tight vessel containing only pure air about 14 times as long as the ordinary miner's lamp burned in the same receptacle, and the products of combustion were the same, it is evident that the acetylene lamp flame does not vitiate the mine atmosphere nearly as much as the ordinary oil lamp flame does.

Lignite Briquets in Germany

The calorific power of the raw lignite from the mines on the Rhine, Germany, is not much more than 3,600 British thermal units, consequently the fuel cannot stand transportation charges, and is used only in the vicinity of the mines. Briquets made from this lignite give 9,000 British thermal units, and when it is understood that good bituminous coal gives but 13,500 British thermal units, it is only logical to wonder at the causes which bring about this unusual heat development. So far as known, this is due to the preparation of the raw lignite and the briquet binder.

The Preparation of Coal

The Necessity of Improved Methods to Ofset Loss of Revenues Resulting from Decreased Percentage of Lump Coal

*By Gordon Buchanan**

MY EXPERIENCE in coal mining began some 35 years ago, and I vividly recall the equipment at our old No. 3 shaft, which was no better, and no worse, than those of our competitors. It consisted of one old boiler, which, following its Sunday cleaning, was often the cause of much picturesque profanity on the part of our Scotch engineer, Andy McKean, by reason of its penchant for squirting so much water through its seams over the fire as to make it an even bet whether the fire would burn or not. Usually, the expansion conquered; if not, we shut down until we could calk seams.

The hoist was a single-cylinder, link-motion engine, with a flywheel on the shaft, which frequently got on a dead center, when it became necessary for Andy to walk on the flywheel spokes to, as he expressed, "put her over." There is still current among the older men in the field a tale relating to a similar installation which ran away one day, due to the breaking of the throttle valve, whereupon the engineer, during the ensuing excitement, was advised by a friendly Scot to "fling a prop in the wheel." The resulting cast-iron shower forever established Sandy's reputation as an artful dodger.

Prior to my time, the coal was forked in the mine before loading into pit cars, the screenings being thrown into the gob, and becoming a fruitful cause of trouble through gob fires. The gobbing of fine coal continued long after forking was abandoned. Many a day I puzzled my brain in an effort to provide means to insure the loading out of this fine coal.

During this period railway equipment consisted of 10-ton cars. Later, a certain few of our favored customers were taken over to the old Canal Street Station of the Alton Railroad in Chicago, where now stands the Union Station, to see the world-beater, a 12-ton car. Strange to say, on certain roads the spectacle of a wood burning locomotive drawing a train containing cars of coal was frequently to be seen.

Our longwall miners prided themselves on their skill with the pick, striving to make their cuts as narrow and as deep as possible. Explosives were practically unknown. I have known men to go home for several days on a stretch because their coal had not broken, only as a last resort using sledge and wedge to bring it down. It was nothing uncommon for a man to put in 14 hours' work daily, although the mine only hoisted 10 hours. As they expressed it, "they could take their time to it."

Under these conditions very little apparatus for cleaning the product was necessary. The bar screen set at an angle in the bottom of loading chute, between tipple dump and car, later supplemented in some few instances by a revolving screen for further sizing of fine coal, and by hand picking on the car, constituted the sum total of preparation. This continued for many years. With the advent of the mine-run system, bringing with it an increased percentage of fine coal, containing an increased proportion of impurities, due partly to a letting down of the standard of skill required in mining, and the loading out by miners of fine coal largely mixed with fireclay which had formerly been thrown into the gob, it became necessary to provide new methods of preparation in order to obtain revenue from fine coal to offset the loss of revenue due to decreased percentage of

*President of the Ohio Valley Mining Co. This address was delivered at the dedication of the Mining Laboratories of the University of Illinois.

lump. This condition was met by the shaker screen, containing various-sized perforations, which permitted of closer sizing of small coal by a single operation, with delivery direct into cars, thereby eliminating rescreening plants.

Following this a campaign of education was carried on with the steam consumers, for the purpose of creating a demand for the smaller sizes produced, due to which the various forms of stokers were introduced and perfected.

The next problem confronting the producer was that of eliminating impurities contained in the smaller, or steam sizes, such as clay, pyrites, etc., which caused clinkers and impeded combustion through clogging of grates, particularly in those stokers employing traveling chain grates. This caused the introduction of the coal washer in its various forms, which for a time solved the problem. Like all other methods, the washer has its limitations, and must be modified to suit the needs and peculiarities of the coal under treatment. As perhaps is well known, it will not produce results with all coals; in fact, with some it will not work at all, and other means must be resorted to. While with all coals where it will work at all, it undoubtedly produces a better article, it has its drawbacks, being prone to freeze in winter, causing increased labor and expense in unloading, while in summer it is a fruitful cause for dispute arising out of claims for shortage at destination, which our railroad friends are prone to shift over onto the shoulders of the coal-mine operator, through the claim that shortage was due to evaporation of moisture in transit.

Having gone through all these phases of the industry in a period of such short duration, all of it passed in conducting hand-operated longwall mines of small individual output, we quickly realized, on entering the Franklin County field, that while the percentage of impurities, due to difference in mining methods, was relatively less per ton, the increase of output necessary, together with largely increased speed of handling, necessitated some method of preparation in addition to screens supplemented by hand picking.

America is far behind foreign countries in the preparation of coal, and we may well take a leaf from their book of experience and profit thereby. The European coals, as a rule, compared with those of America, are poor, thin beds, and require much care and labor in properly preparing them for market. In Great Britain the coal is much better; nevertheless, a large share of the expense involved in equipping their mines is devoted to the machines for cleaning and sizing. Our American coals, as a rule, have a better average quality than the foreign coals, and have required less attention to prepare them for market. Today, competition is such that the preparation often is the determining factor in retention of trade.

One of the curious phases in the marketing of coal is the fact that for anthracite the trade pays a premium for certain of the small sizes, notably chestnut, whereas in the bituminous fields the opposite is the case, and at times a premium is paid for the large sizes, the small being frequently a drug on the market. The reason for this is that appliances for burning domestic soft coal are not as efficient as those for anthracite. It would therefore seem as though there was a large field here for the enterprising manufacturers who will develop and market, at reasonable cost, devices which are fitted to burn the smaller sizes of soft coal without smoke. This is now being done in certain types of house heating furnaces and boilers, but as yet no practical efforts have been made to apply this principle to the ordinary heating stoves of small size, nor to the cook stoves, which make up the great bulk of the appliances for consuming soft coal.

In searching for new methods to improve the quality of our output, our company reached the conclusion that we must look for some mechanical process which would work perfectly at high rates of speed. We therefore searched the anthracite field thoroughly, and also examined certain of the foreign fields. We found a number of appliances, all of which had good points, some more and some less than others. For our particular kind of coal, after careful practical tests, we concluded that one certain type of machine would do the work better than others, and we therefore installed the same. The result has more than warranted our belief in its efficiency. It is true that it is not absolutely automatic, care being necessary to see that it is not crowded beyond its capacity. This particular device utilizes gravity, friction, and centrifugal force to separate the slate and bone from the coal. When adjusted to the particular size of coal and fed within its capacity, it automatically rejects slate and bone, delivering the coal in a remarkably pure state. The coal must be first closely sized, and delivered to machines built to suit the various sizes. Like all such devices, it has its limitations, and probably would not work on all kinds of coal.

In conclusion, it seems apparent that more thought and care bestowed upon the preparation of our Illinois coals should result in the expansion of our selling territory, and in the establishment of a reputation for quality which should prove sheet anchors in times of depression.

The United States Geological Survey gives the following data:

In 1912 the total production of coke was 43,916,834 short tons, valued at $111,523,336, an increase of 8,365,345 tons in quantity and of $27,392,487 in value over 1911.

A marked progress has been made in the gradual substition of retort ovens for the wasteful beehive type and in the shifting of the coke making industry from the vicinity of the mines to the centers of manufacture and population, where the by-products may be readily utilized.

Schaefer Method of Resuscitation

Prone Pressure Method of Resuscitation of Those Asphyxiated or Who Have Received Electric Shocks

In a paper read in 1908, in Chicago, before the American Medical Society, Prof. E. A. Schaefer described the "Prone Pressure Method" of artificial respiration. After a number of experiments he and Doctor Herring, of the University of Edinburgh, Scotland, "came to the conclusion that

Fig. 1

for the performance of artificial respiration without the aid of bellows or other apparatus a pressure method is best, and that such a method is more efficient with the patient in the prone position, as shown in Fig. 1, and with the pressure applied vertically over the lowest ribs. In this way not only is the thorax compressed, but also the abdomen against the ground. The pressure against the abdomen forces the viscera against the diaphragm, which is thereby moved upward, driving air out of the lungs. On relaxing the pressure, the elasticity of the parts causes them to resume their former shape and volume, and the air is drawn in through the glottis." This method Doctor Schaefer termed the "Prone Pressure Method." The prone method has been recommended by the American Medical Association, American Institute of Electrical Engineers, and the National Electric Light Association.* It has a number of advantages over the supine system of artificial respiration, where the arms are raised and lowered and pressure exerted on the abdomen of the patient, who is on his back.

Charles A. Lauffer, M. D., in his book on "Resuscitation,"† says there are four facts in the Prone Pressure method of resuscitation that require emphasis:

1. The position of the patient, who is laid on his stomach, face turned to one side, as shown in Fig. 1, so that the mouth and nose do not touch the ground. This position causes the tongue to fall forward of its own weight, and so prevents it falling back into the air passages. Turning the head to one side prevents the face coming in contact with water, mud, or dirt, and one man can commence operations without any assistance.

2. Posture of the operator which permits him by straddling the patient to work with a degree of ease and little muscular exertion.

3. Mode of operation will not injure liver or ribs.

4. Rate per minute and duration of operation.

RULES FOR RESUSCITATION

1. Lay the victim on his stomach, and if his teeth are clinched pry his mouth open. This is particularly necessary if the patient has false teeth or tobacco in his mouth. In trying to remove these obstacles the mouth must be blocked, as the teeth may snap shut and catch a finger, for which reasons pliers have been suggested, as well as that one or two of the front teeth be knocked out. In many cases such extreme measures will be unnecessary.

2. The arms of the subject should be extended beyond the head as shown in Fig. 1, although Dr. C. A. Lauffer, Medical Director of the Westinghouse Electric and Mfg. Co., places one arm straight above the body and the other at right angles as in Fig. 2.

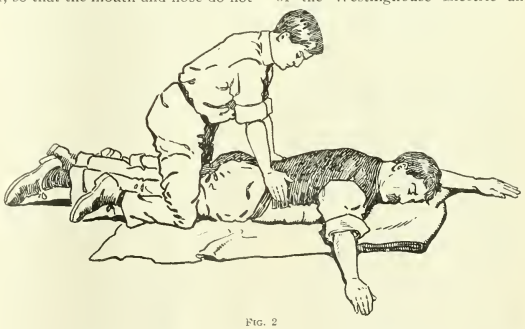


Fig. 2

3. Artificial respiration should commence at once when the patient

* The National Electric Light Association have copyrighted a Resuscitation Chart and Booklet both of which can be had for 8 cents by addressing the Secretary, 29 W. 39th St., New York City.

† John Wiley & Sons, New York City. Price 50 cents.

has had an electric shock, but in the case of mine-gas asphyxiation he should be removed to pure air on the intake and then work commenced on him. Delay in either case may prevent resuscitation.

4. Kneel, straddling the patient's thighs and facing his head. The next move is to locate with both hands the bones of the pelvis, the muscles of the small of the back and the floating ribs. With the lowest ribs located, the operator places his spread hands, with the thumb nearly parallel to the fingers, so that the little finger curves over the twelfth or last rib. The hand must be free from the pelvic bones and resting on lower rib.

5. With arms held straight, swing forward slowly so that the weight of the body is gradually brought to bear upon the subject, as shown in Fig. 2. This operation, which should take from 2 to 3 seconds, must not be violent—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs.

6. Now *immediately* swing backward so as to remove the pressure, but leave the hands in place, thus returning to the position shown in Fig. 1. Through their elasticity, the chest walls expand, and the lungs are thus supplied with fresh air.

7. After 2 seconds swing forward again. Thus repeat deliberately 12 to 15 times a minute the double movement of compression and release—a complete respiration in 4 to 5 seconds, the operator following the natural rate of his own deep breathing—swinging forward with each expiration, and backward with each inspiration.

8. Artificial respiration has revived men after 2 hours of continued work. A feather may be held at the nostril to ascertain if the air is going in and out of the lungs. This will require a second person, and in lieu of a feather tissue paper or a thread may be used. This naturally will help the operator in continuing his efforts, as he will be sure the passages are not stopped. After natural breathing begins, carefully watch that it continues. If it stops, start artificial respiration again.

During the period of operation, keep the subject warm by applying a proper covering and by laying beside his body bottles or rubber bags filled with *warm* (not hot) water. The attention to keeping the subject warm should be given by an assistant or assistants.

9. Do not give *any liquids whatever* by mouth until subject is fully conscious.

Double Explosion of Dynamite

The following is a translation from *Zeitschrift fuer das gesamte Schiess-und Sprengstoffwesen*, etc., of Munich, by W. H. Blumenstein, Pottsville, Pa.

A supervisor of blasting was severely injured by a blast in a lignite coal mine noted for its firedamp and coal dust, situated in the official district of the mining corporation Klagenfurt. The charge which had apparently exploded, again exploded at the very moment when the man approached the spot for the purpose of determining the result of the first blast. The explosive used was a permissible dynamite manufactured by the firm of Noble, in Vienna, and was composed, according to the statement of the firm, at a density of 1.25, of 52 parts by weight nitroglycerine; 34 parts by weight soda (crystals); 14 parts silica.

The box containing the explosive had been received only 8 days previously. A hole 1,200 millimeters (4.5 feet) deep and 30-35 millimeters (1¼-1½ inches) in diameter had been drilled in coal under the roof of a drift. The charge consisted of four cartridges of permissible dynamite, 26 millimeters (1 inch) in diameter, 240 millimeters (9½ inches) long, and weighing 100 grams (4 ounces) each. The uppermost cartridge was the ignition cartridge. A good plastic clay of a thickness of 400 millimeters (16 inches) was used as tamping. The ignition was by electric detonator, the cap, No. 7 of 1.5 grams fulminate of mercury, was new and dry.

The circumstances, according to the statements of the miners and the injured supervisor, were as follows: The charge was inserted, tamped, and ignited by electricity. It went off at once with a loud report, but did not produce any result. The miners and supervisor returned after about 6 minutes to the level, the former passing the place of the blast and continuing their work. The supervisor approached the blast hole from which some smoke rose, but noticed a peculiar odor, and consequently withdrew in haste. At this very instant, approximately 8 minutes after the first blast, a second blast occurred which only now caused a fall of coal. The supervisor, who then stood about 3 feet from the drill hole, sustained injuries of the eyes and of the head. According to another supervisor, a similar case of the subsequent explosion of a charge which had exploded once happened in the same mine about one year before.

The royal mining corporation Klagenfurt requests information of similar occurrences in other mines with safety explosives of the type mentioned, and what measures had been taken to prevent repetition of this accident.

New Mexico School of Mines

The New Mexico School of Mines was founded by an Act of the legislature in 1889. The Act provided for the support of a school by an annual tax of one-fifth of a mill on all taxable property. By the terms of the Enabling Act, under which New Mexico was admitted to statehood, the School of Mines became possessed of 150,000 acres of land. At the first session of the state legislature the appropriation for the school was $22,500.

Notes on Mines and Mining

Reports on Conditions and Other Matters of Interest in Various Coal Fields

By Special Correspondents

CANADA—*Duty on Rescue Appliances.*—The changes in the customs tariff announced by the Minister of Finance include "miners' rescue appliances, designed for emergency use in mines, where artificial breathing is necessary in the presence of poisonous gases, and automatic resuscitation apparatus for artificial breathing, to aid in the saving of human life." These are placed on the free list. For some time past the duty on mine rescue apparatus has been rebated upon application, but it is much more satisfactory to have these appliances placed definitely on the free list. It is a question whether the Federal government can levy duties upon articles required by law in some of the provinces, when such articles are not manufactured in Canada.

OHIO

Judge Phil M. Crow; Prof. M. B. Hammond; J. M. Roan, coal operator; J. C. Davis, State Inspector of Mines; and Morris Albaugh, miner, have been appointed by Governor Cox, of Ohio, to investigate and report on an equitable method of weighing coal at the mine. The commission is to do its work this summer and report to the legislature next January. It will determine whether miners should be paid on the present plan for the screened coal or for coal as it comes from the mine. It is proposed to enact laws covering the subject, for which reason the commission has but one coal miner and one coal operator, the remaining members having been selected by Governor Cox without consulting either the operators' or the miners' organizations.

Twenty indictments returned against the Grand Trunk & Western Railway for alleged rebating by the United States District Court render that company liable to fines aggregating $100,000. It is charged that the company violated the Elkins act by giving rebates on coal shipments made between the Belmont Coal Mining Co., of West Virginia, and the Battle Creek Coal Co., of Battle Creek, Mich.

On January 6, Raccoon Creek, near Wellston, Ohio, overflowed its banks, flooding the Jackson Mining Co.'s mine, located 3 miles from Wellston, throwing 150 men out of employment. H. C. Morrow, general manager, and also secretary of the Morrow Prospecting Co., says they installed a turbine pump with a capacity of 5,000 gallons per minute with 14-inch discharge, and they expected to have the mine running to full capacity by the middle of July. The Domestic Coal Co., whose mine was flooded in January, expected to be shipping coal again July 1.

PENNSYLVANIA

Five cases involving coke rates from the Connellsville region of Pennsylvania, have been under consideration nearly a year by the Interstate Commerce Commission. The principal one was brought by the Coke Producers' Association in the Connellsville region against the Baltimore & Ohio, the Pennsylvania, and several other roads. It attacked as unreasonable and unjustly discriminatory all Connellsville coke rates and declared that they were preferential as compared with West Virginia rates. The commission held that the rates to Youngstown, Canton, Cleveland, and Toledo, Ohio; North Cornwall, Robesonia, Reading, and Philadelphia, Pa.; Baltimore, Md., and Newark, N. J., were unreasonable, and prescribed rates averaging about 12 per cent. lower than existing rates, although in some instances no change was made. Also it was held that the present relationship of rates between the Connellsville district and the Fairmont district, in West Virginia, was not discriminatory against the former or unduly preferential to the latter.

Owing to the failure of the First-Second National Bank of Pittsburg, Federal Judge C. P. Orr, on July 10, placed the United Coal Co., the Somerset Smokeless Coal Co., the Naomi Coal Co., the Merchants Coal Co. of Penna., the Isabella-Connellsville Coke Co., and the Pittsburg and Baltimore Coal Co., in the hands of receivers. The petitions for this action were made by Lucien Hill, a citizen of Maryland. In the case of the Isabella-Connellsville Coke Co., the company itself joined in the petition. Three receivers were appointed for each company with the exception of the United Coal Co., for which four were appointed. The receiverships are made up of the several following men: James D. O'Neil, general superintendent of the several companies; Samuel A. Gilmore, W. K. Johnson, Thurston Wright, and Robert P. Watt, each serving on several of the receiverships. This action was taken to protect the property and assets of the companies, and will not interfere with their operation.

MICHIGAN

Detroit, Mich., is said to receive a daily average of 700 cars of coal, amounting during a year to 8,736,000 tons. More coal is shipped to Cleveland than to Detroit, but the big consumption there is in part accounted for by the enormous tonnage used to supply the lake vessels. The largest users of coal in Detroit are the Solvay Process Works, the Edison Illuminating Co., and Detroit street car companies. The Solvay company, on account of their coke ovens, use from 60 to 100 carloads daily, it is stated.

The United States Geological Survey has published some interesting data regarding the coal fields of Michigan: that they occupy an isolated basin covering approximately 11,000 square miles, principally in Bay and Saginaw counties, which is

almost the center of the Lower Peninsula. They are estimated to have originally contained 12,000,000,000 tons of coal, from which the exhaustion to the close of 1912 has amounted to about 30,000,000 tons.

BRITISH COLUMBIA

Cost of Power.—The city of Calgary has been studying the power situation in all its phases and on April 11 a report by an expert was handed in which deals with the costs of power from several sources.

It shows that the following sources of power are available in Calgary: Hydroelectric power by contract with Calgary Power Co.; power obtained from coal-fired boilers and steam-turbine-generator sets; power obtained from natural-gas-fired boilers and steam-turbine-generator sets; natural-gas engines operating generators; combination of coal-fired boilers and steam turbines with power from the Calgary Power Co.; combination of gas-fired boilers and steam turbines with hydroelectric power from the Calgary Power Co.; natural-gas engine power supplemented by power from the Calgary Power Co.

By contract with the Calgary Power Co., power is sold to the municipality at the substation of the power company at $26 per horsepower year for the first 5,000 horsepower. The city has not been properly safeguarded against interruptions and this power has not been ready for utilization for 24 hours per day.

The comparative costs of power from the different sources on a plant capacity of 45,000 kilowatts eventually equipped with 5,000-kilowatt units show as follows for the different methods of generation:

Steam generated from coal. The capital costs are estimated at $46 per kilowatt. The costs per kilowatt year on a 50-per-cent. load-factor basis vary from $37.20 to $32.36. The costs per kilowatt hour on 50-per-cent. load-factor basis, vary from .85 cent to .74 cent.

Power from gas-fired boilers. Capital costs are $45 per kilowatt. Operating costs per kilowatt year, 50-per-cent. load-factor basis, vary from $31.38 to $27.34. Cost per kilowatt hour, 50-per-cent. load-factor basis, varies from .71 cent to .62 cent.

Power from natural-gas engines. Capital cost per kilowatt is $91. Cost per kilowatt year, 50-per-cent. load-factor basis, varies from $26.46 to $24.13. Cost per kilowatt hour, 50-per-cent. load-factor basis, varies from .60 cent to .55 cent.

A lower load factor than 50 per cent. would favor steam and a higher one, gas.

The report concludes with the recommendations as follows:

1. To conclude a contract with the Calgary Power Co. at $26 per horsepower year for the first 5,000 horsepower; $25 per horsepower year for the next 1,000 horsepower; $24 per horsepower year for the next 1,000 horsepower; $23 per horsepower year for the next 1,000 horsepower; $22 per horsepower year for the next 1,000 horsepower; $21 per horsepower year for the next 1,000 horsepower; $20 per horsepower year for all over 10,000 horsepower, provided that effective guarantees can be obtained for reliable service.

2. To purchase for immediate use steam turbines and boilers, as this is considered the only quick solution of the power situation, which is critical at the present time and may be intolerable next winter unless something is done quickly.

3. For future extensions thereafter, if there is no change in the art in the next few years, steam turbines with gas-fired boilers will be our recommendation, in spite of the greater economy of the gas engine.

4. Should the development of the gas engine or gas turbine, or some other improvement, render it possible to utilize other sources of power than that recommended, there will be no difficulty in introducing the latter.

Our recommendations are as above in spite of the fact that the gas engine, from a power standpoint, is the cheapest. The natural gas engine is hampered as follows:

(1) The great capital investment, 100 per cent. more than for steam equipment.

(2) The whole service will depend upon the integrity of a pipe line 172 miles long.

(3) The large gas engine is not in such a stage of development as yet to insure its success in your plant, and the use of smaller units would increase the capital and operating costs considerably over those indicated in our report.

The advantages of steam as compared with gas in this case are as follows:

(1) The decreased capital cost involved.

(2) The utilization of natural gas with coal as a standby in case of the failure of the pipe line.

(3) The establishment of a plant in which every item has been tried out for years and in which no experimenting is necessary.

Conditions in the Crow's Nest Pass coal fields are much improved and the district is rapidly recovering from the effects of the strike which last year crippled the coal mining business thereabouts. Reports show the coal is purchased as soon as mined.

Mining generally shows signs of a strong revival. It is believed that capital will turn more and more to this form of industry now that the real-estate booms are declining.

J. H. S.

West Virginia Mining Institute Meeting

Probably the most enjoyable meeting of the West Virginia Mining Institute was held at Morgantown, W. Va., June 24-26.

The only regrettable part of the occasion was that many members from the southern part of the state were unable to be present, even Messrs. J. J. Lincoln, R. S. Ord, John Laing, and Frank Haas were too much occupied with their business to attend; however, Mr. Grady, of Bluefield; Mr. Clagett, from Pocahontas; Messrs. Robinson and Guy, from the Clinch Valley coal field; Mr. Schubert, from Roanoke; and Messrs. Krebs and Robinson, from Charleston, were in attendance. It was particularly unfortunate that the members from the

distant parts of the state could not attend, because an opportunity was offered them to visit some of the modern surface arrangements in the Connellsville region and also some model coke-oven plants.

At the Mt. Braddock plant of W. J. Rainey, the visitors saw several 5-ton Mitchel coke ovens watered in 4 minutes, pushed and loaded on the car in 3 minutes, making a total of 7 minutes. They also saw beehive ovens at Continental No. 1 mine with waste-heat flues saving the H. C. Frick Coke Co. $60 per day in coal. A number of the members went in this mine to see the concrete shaft bottom in which General Manager Lynch takes particular pride. After leaving Mt. Braddock, Leisenring No. 1 plant of the H. C. Frick Coke Co. was visited, where the coke ovens, rescue plant, power plant, and swimming pool were inspected. The visitors were supplied with a special train over the Baltimore & Ohio Railway from Morgantown to the places mentioned that stopped on the way back to permit the members to visit the hydroelectric plant which is being erected on the Cheat River near Cheat Haven, and which was described by George F. Rowell, engineer in charge.

The members were welcomed to Morgantown by Mayor T. S. Stewart, and were granted the use of Mechanical Hall for their deliberations by Dean of the College of Engineering, C. R. Jones. President Neil Robinson, of Charleston, responded in his usual happy way for the Institute members, who then proceeded to take anything they wanted in Morgantown.

They took lunch first, then the trolley car to Sabraton, where the American Sheet and Tin Plate Co.'s mill was inspected, from the heating furnaces to the packing. Thin sheets are annealed, then rolled in pairs; these pairs are again annealed and with another pair are rolled together; after another reheating, the four sheets now in one bunch are rolled with another pair of sheets. This bunch is cobbled and cut to the proper size, after which the sheets are separated by hand. Some skin readily, others stick, while still others will not separate by ordinary treatment. The good sheets after separation were carried to a pickling tank where the iron oxide, that forms when red-hot iron or steel is brought into the air, is removed by acid. From this on the sheets were polished, then dipped in tin, or if for stove pipe into a burnishing solution. After this latter treatment the sheets are polished and inspected by young women who become very expert in detecting flaws and in pitching the plates into three piles, using either hand in the operation. President Fohl, of the Coal Mining Institute of America, became so interested in this operation that George Gay was under the impression that he was a scout for the Pittsburg base ball team looking for pitchers.

The inspection of this mill was both interesting and instructive. On the return trip to Morgantown Dr. I. C. White said the trolley passed over the center of the Connellsville coal area, which was located at Morgantown and not at Uniontown, Pa., as many thought. He also pointed out the Pressed Prism Plate Glass Co., which was not visited because of its being shut down on this afternoon. The sand used in glass works in the vicinity of Morgantown comes from what corresponds to the Pottsville sandstone. On reaching Morgantown the entire party was easily persuaded to indulge in a joy ride which ended without accident at Mt. Chateau, where all the available fried chicken and waffles, etc., etc., etc., were devoured at somebody else's expense.

After this delightful repast there was another joy ride to the far west, and finally back to Morgantown over a road from which could be seen one of the finest landscapes to be viewed in any country, and probably the best in West Virginia. In the absence of President Neil Robinson, who was obliged to return to Charleston, Mr. George T. Watson, vice-president of the Consolidation Coal Co., presided at the business sessions.

Exceptions have been taken to manufacturers' representatives reading papers describing their specialties, and in one instance special badges were issued to separate the sheep from the goats. At this meeting the Artisans not only presented the best but the most useful and instructive papers, a matter which caused considerable comment.

The visiting members of the institute were given a banquet at the Madeira hotel by the Morgantown Board of Trade.

Dr. I. C. White, in spotless white, was toastmaster of the occasion. Doctor White bought two suits of duck in Porto Rico, Cuba, or Panama, and invited a number to guess their cost. In order to please him, some irreverent person stated $1.50, which brought a smile from the doctor, who admitted they were not fire-sale goods. After the menu had been "menued" and the absent toasters had been toasted, Doctor White called on H. M. Wilson, Dr. T. E. Hodges, Floyd Parsons, Prof. E. N. Zern, and J. B. Johnston who substituted for Edward W. Parker and exploded statistics for 30 minutes. Jabez B. Hanford, the final speaker, who is general superintendent of the Elkins Coal and Coke Co., and lives in Morgantown, said: "I was greatly surprised on my visit to the University to note that the Mining School was so well equipped to educate the young men of West Virginia in their state's greatest industry. This fact ought to be more generally known by operators, and their influence exerted to urge young men of this state to take a mining course at the West Virginia University."

Dr. T. E. Hodges, President of the University, became eloquently indignant when speaking of the aspersions lately cast by Senator Martine, of New Jersey, on the fair state of West Virginia; also he outlined the work of the University, which he said was intended that the young men of his state might be fitted to enter into the duties of coal mining.

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

[The answers to questions 27 and 28, printed in the June issue, were many in number, but lacked some essential details. The questions are therefore presented again.—Editor.]

27. In boring a hole through a coal barrier 140 feet wide in a 5-foot seam, what is the greatest difficulty you would expect to meet, and how would you overcome it, the head of water being 120 feet?

28. An entry 3,600 feet long falls 350 feet 6 inches. (*a*) What is the gradient of the road? (*b*) What kind of haulage would you install on such a road to get up 800 tons a day? Give reasons for and describe the salient points of the installation.

33. Does the reading of a water gauge at the foot of an air-shaft differ from one taken at the fan on the surface? If so, which is the greatest? Illustrate by a practical example?

34. A self-acting jig plane has an inclination of 25 degrees and a length of 500 feet. A loaded car weighs 3,500 pounds; an empty car, 1,500 pounds; balance weight, 4,800 pounds; and the rope 1.6 pounds per linear foot. How many cars are used per trip, assuming the coefficient of friction to be one-thirtieth?

Answers for which Prizes Have Been Awarded

Ques. 25.—The capacity of a room is 6,548 cubic feet and it has the following atmosphere: Air, 92.90 per cent.; marsh gas, 7.06 per cent.; carbon dioxide, .04 per cent. How many cubic feet of oxygen, nitrogen, marsh gas, and carbon dioxide will there be in this room, the temperature being 65° F. and the barometric pressure 29.925?

Ans.—The volume remains constant because the atmosphere is under constant pressure and constant temperature.

To find volume of air: $6{,}548 \times .929 = 6{,}083.0920$ cubic feet air.

But as the air is composed of oxygen and nitrogen and in the following parts: oxygen, 20.7 per cent.; nitrogen, 79.3 per cent. Therefore solving for number of cubic feet of each: $6{,}083.0920 \times .793 = 4{,}823.8919 +$ cubic feet of N; $6{,}083.0920 \times .207 = 1{,}259.0004 +$ cubic feet of O.

Calculating CH_4, $6{,}548 \times .0706 = 462.2888$ cubic feet of marsh gas.

Calculating CO_2, $6{,}548 \times .0004 = 2.6192$ cubic feet CO_2.

Therefore we obtain the following:

Oxygen, 1,259.0004+ cubic feet. Ans.
Nitrogen, 4,823.8919+. Ans.
CH_4, 462.2888+. Ans.
CO_2, 2.6192+. Ans.

D. J. Jenkins
Stockett, Mont.

Second prize, John G. Jones, Johnstown, Pa.

Ques. 26.—It is desirable to remove all the coal from a 5-foot seam below a concreted reservoir, containing water for public purposes. Indicate a system of working the coal to do as little damage as possible to the reservoir. Seam is 560 feet below reservoir.

Below we have printed the three best answers to Ques. 26, but since all of them are of approximately the same merit, but each treats the subject a little differently, we ask for comments from the readers of The Colliery Engineer upon their merits. The two papers receiving the most commendatory letters will be awarded the prizes.—Editor.

Ans.—Ques. 26 reminds me of an incident in South Wales, where a 7-foot seam was mined on the longwall system, working only one shift of 10 hours per day on the coal and a night shift for repairs and gobbing along the old roads and waste places at the face. This was an expensive method, owing to repairs which became necessary to the damaged houses and other buildings on the surface.

In another portion of the same valley the same company worked a 4-foot seam of coal on the advancing longwall system, and it was found necessary to work underneath a public school. The question arose as to the most economical method of taking out the coal. The method shown in

Fig. 1 was adopted. In the direction of the faults the angle of fracture of the roof and the floor and the amount of gobbing material available were thoroughly considered, and it was decided to drive entries *A* and *B* a sufficient distance apart and a safe distance outside the angle of fracture, then cross-cut at intervals for ventilation. So *A* and *B* were driven their required length, and then we came back to *c* and *d* and adopted the Carey, or Nottingham, longwall system, that is, the track was laid parallel with the face and as soon as a block of coal was taken out sufficient to move the track, it was moved without any delay.

The men worked in three shifts of 8 hours each. Rubbish for packing came in in empty cars which were unloaded and then filled with coal, the cars going in and out, as shown in Fig. 1.

The work was thoroughly done, the timbers were taken out in the gob, which was tightly packed with rubbish from other parts of the mine, and no damage to the school resulted, and only a few inches of settlement were recorded over the whole area, therefore, it is seen that that particular portion settled uniformly. Had it only been worked on one shift, however, it would probably have caused the ground to subside in one part sooner than in another, thereby causing some damage.

So, without going into any particular data I am answering this question by an example taken from my own practical experience, which method, I believe, will prove satisfactory in the locality referred to in the question. Coal Miner No. 1

Ans.—The question does not state the size of the reservoir; but assume it to cover a large area of surface. It is considered a fact in mining, that the overlying strata of a coal seam will fall 40 feet high per 1 foot of coal height; therefore, the overlying strata in this case would fall 5 ft. × 40 ft. = 200 feet high. Therefore, this would not be high enough to cause any damage to the reservoir. But as the overlying strata above the 200 feet may be of a shaly nature, there is a probability of a sinkage occurring that may do considerable damage to the reservoir through causing crevices or breaks to reach the surface. The best method to adopt to remove this coal would be the panel system; that is, drive a set of entries up to their limits or boundaries; then start a set of rooms at the face and work these rooms up to their limits. When they

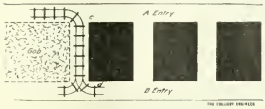


Fig. 1

reach this, start them immediately on the retreat. As the pillars are being removed, pack walls or gob cribs should be placed at different intervals. The placing of these walls should be guided by the nature of the overlying strata. By the placing of these rock walls or gob cribs, caving would be prevented. There may be a sinkage occur, but this would not be great enough to reach the surface or cause any crevices that would damage the reservoir.

Coal Miner No. 2

Ans.—The longwall method would probably suit the above circumstances better than any other method now in use, although in my mind, a section of the strata overlying the seam is the chief feature in forming a decision. In the first place I will assume the reservoir so near the shaft that it would be wise to extract coal right away from the shaft, so as to avoid a fracture by leaving in shaft pillars. The roads would be set out to suit the requirements of the mine, depending greatly on the position of shaft, the area to be worked, dip of seam, etc. The area of the seam around the shaft, which, under any other system of working would have been left solid as far as possible to form a shaft pillar, I should have well packed, by sending material into the mine to make up what would be found short, after utilizing all that would be produced in the mine. The debris from the shaft sinking could be used. I should have cross-headings every 50 yards apart, and gateways every 10 yards. I should rip the roof 1 yard in thickness, advancing with the coal face. The amount of stone shot down would build packs on each side about 4 feet 6 inches thick. I should have distance between packs 10 feet 6 inches in gateways, also in cross-headings; as either cross-heading or gateways advanced I should follow with a second ripping of say 2 feet; this stone I should build up in the sides of the gateways and heading, pulling in the packs to say 4 feet from each other. Build packs as solid as possible and wherever possible, put in soft wood cogs at the corners of the packs, where gateways break off the cross-heading. I have known this method of working to cause a depression on the surface, in which water would accumulate, from which ditches had to be cut to let it away, since such water couldn't get through the fissures in the strata, the seam being about 50 fathoms deep and about 3 feet thick. If the roof is of such a nature as to break behind the packs, the gateways may be set further apart. By using fallen stone in the gob, intermediate packs may be built through the gob parallel with the gateways, or square packs may be built in the gob, say every 3 yards, as the face advances, such square packs being about 3 yards on the side. Only practical results would show the improvement in relation to economy and safety, under such circumstances.

Coal Miner No. 3

Fusion of Fire and Silica Brick

What is commonly called "high-grade firebrick" has a fusion point of 3,250° F. As the proportion of silica is increased, the fusion point becomes lower until a mixture commonly called "quartzite brick," containing 80 per cent. silica, is reached. From this point the fusion temperature rises until the true silica brick containing 96 per cent. silica is reached. These stand a temperature of 3,550° F., when they commence to fuse.—*Improved Equipment Co.*

NEW MINING MACHINERY

Connecting Steam Turbines for Operating on Exhaust Steam

By George H. Gibson

The steam turbine is unrivaled as a prime mover wherever rotary machines can be directly driven, and in contrast to reciprocating prime movers, maintains a good steam economy for long periods and, if properly designed, is easily restored to its original economy or can be modified for changed steam conditions by the substitution of a few inexpensive, interchangeable parts. It is simple and compact, and the few running parts are readily accessible for repair, is light in weight, does not require heavy and expensive foundations, and contains no reciprocating parts to cause tremors or vibration.

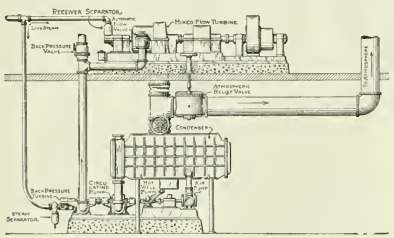


Fig. 1. Back Pressure Turbine Auxiliaries

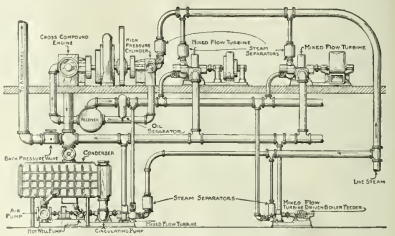


Fig. 2. Mixed-flow Turbine Driving Auxiliaries

Most auxiliary apparatus installed in steam-power plants is adaptable for direct driving by steam turbines; particularly so are centrifugal boiler feed-pumps, circulating pumps, hot-well pumps, centrifugal blowers, and compressors, exciter dynamos, etc. Centrifugal high-vacuum air pumps are also coming into use and by means of gears the turbine can be adapted to driving slow-speed induced draft fans, coal and ash conveyers, reciprocating air pumps, automatic stokers, large low-head circulating pumps, etc.

The steam-turbine driven auxiliary can be operated whenever steam is available, regardless of whether or not the main units are in operation. Rather than detracting from the efficiency of the plant as a whole, it may be used to increase the plant efficiency, as compared with the reciprocating or the electrically driven auxiliary. This follows from the facts that, (1) the exhaust from auxiliary turbines operated on high-pressure steam can be used for heating the feedwater, for which purpose it is perfectly suited; and (2) that when operated on low-pressure steam, the auxiliary turbine is much more efficient in using such steam than is the low-pressure cylinder of the most efficient compound or triple-expansion engine.

This point may be illustrated by a few figures. A simple non-condensing engine of moderate size will, when in good condition, develop an indicated horsepower on about 30 pounds of steam per hour, or the same engine running condensing will require about 24 pounds of steam. If, however, instead of exhausting directly into the condenser, the steam from this engine be first passed through a turbine, a horsepower may be developed by the combination on about 15 pounds of steam. In other words, where a plant is equipped with reciprocating auxiliaries, the amount of power available for driving exciters, pumps, fans, etc., may often be doubled without the use of an additional pound of live steam.

The arrangement just suggested does not in any way limit or impair the flexibility of the plant, nor diminish its resources in case of accidental derangement for, should low-pressure steam not be available at any time, the turbine-driven auxiliaries can be operated economically on live steam exhausting to atmosphere.

It is frequently asserted that there is no harm in using inefficient high-pressure steam-driven auxiliaries, since the exhaust can all be utilized in heating boiler feedwater. However, in some power stations the amount of exhaust steam available from the auxiliaries has been found to be larger than required for feed heating, resulting in waste, and in any case this plan amounts in the last analysis to nearly the same thing as using the live steam for feed heating, which is uneconomical

if the heat can be obtained more cheaply from other sources.

An arrangement in which the auxiliaries are driven by back-pressure turbines exhausting into an intermediate stage of the main turbine is shown in Fig. 1, while an arrangement with auxiliary turbines receiving steam at about atmospheric pressure from the intermediate receiver of a compound engine is shown in Fig. 2. In the latter the auxiliary turbines are of the mixed-flow variety, in order that they may be operated on high-pressure steam when the main engine is not running, or in case the amount of exhaust steam obtainable from the receiver should be less than is needed for their operation. This also permits of running the auxiliaries on high-pressure steam non-condensing when the main engine is shut down, or of running some of the auxiliaries on low-pressure steam and others on high-pressure steam condensing.

In many plants simple or compound reciprocating engines are already installed for supplying low-pressure steam. The engine, however, may exhaust more steam than is required and the excess may not be sufficient in quantity to justify, or the type of the engine may not permit, the use of a condenser. Again, where the requirements for steam are very fluctuating, lasting only little more than half the year and be installed as shown in Fig. 3, to be operated on the surplus of exhaust steam not required for heating, and exhausting into a condenser, the cooling water being obtained from a stream or a cooling pond or by the installation of a cooling tower. If the demand for steam for heating purposes at any time exceeds that supplied by the engine, the same turbine may be arranged to operate non-condensing, assisting the engine in carrying the heating load. In this way the maximum efficiency is obtained at all seasons, and nearly or quite twice as much power is developed from a given amount of fuel, while performing the same heating service. The piping arrangement shown in Fig. 3 permits either the engine or the mixed-flow turbine to exhaust all the exhaust steam. During the period of the heavy heating load, the turbine is supplied with high-pressure steam and exhausts into the heating system. During the summer, however, the turbine runs on the engine exhaust and exhausts into the jet condenser. In case the amount of steam supplied by the engine is insufficient to keep the turbine in operation, live steam can be drawn directly through the high-pressure nozzles.

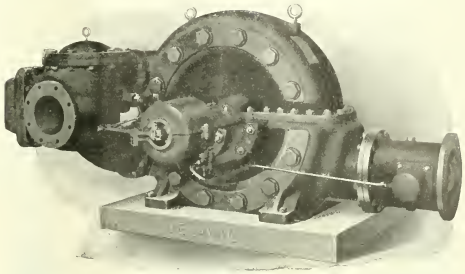


Fig. 5. De Laval Steam Turbine of the Velocity-stage Type

In designing a new plant to take advantage of this "two-stage" method of operation, it would be better, rather than introduce the reciprocating engine with the consequent oil in the exhaust, to employ two turbines, as shown in Fig. 4, so arranged that both may supply exhaust steam for the heating system reaching a maximum for only a month or two, large quantities of steam will be wasted. In such plants, a low-pressure turbine can directly into the heating system through the open feedwater heater, which is equipped with an oil separator of sufficient capacity to handle during periods when the heating load is heavy, while at other times, one may run as a high-pressure and the other as a low-pressure turbine,

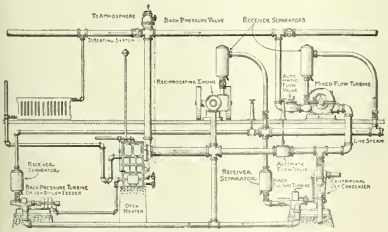


Fig. 3. Mixed-Flow Turbine, Operated in Connection with Steam-Heating System

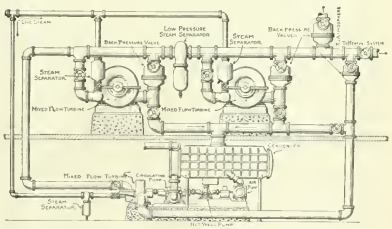


Fig. 4. Two Mixed-Flow Steam Turbines in Exhaust Steam Heating and Condensing System

giving an efficiency equal to that of a complete high-pressure condensing turbine or twice the capacity of the individual turbines. At the same time, the auxiliaries; that is, the condenser pumps, boiler feed-pumps, fans, etc., may be driven by turbines, and used for balancing the load at times when there would otherwise be either a deficiency or a surplus of steam at the intermediate pressures.

It is a frequent practice, when designing mills or factories where there is the expectation of an increasing demand for power, to install only the high-pressure cylinder of a compound engine, with the intention of installing the low-pressure cylinder later on. Proprietors of such mills now find it to their advantage to install a low-pressure turbine in place of the intended low-pressure cylinder, as they thereby secure a much greater increase in power from the same amount of steam. Moreover the low-pressure turbine may be operated on high-pressure steam exhausting to atmosphere if the condensing water should fail, giving emergency possibilities not possessed by the engine if carried out as a compound.

The type of turbine most suitable for such purposes as are discussed in this article; that is, where the turbine may be called upon to operate upon low-pressure steam condensing or high-pressure steam non-condensing or as a mixed-flow turbine, is undoubtedly, for small units, the velocity-stage turbine, as illustrated in Fig. 5, which shows one of the newest forms of these machines made by the De Laval Steam Turbine Co.

Turbines of this type may be changed over from high-pressure condensing service to back-pressure or low-pressure service by the mere substitution of nozzles of the proper expansion ratio. As these nozzles are secured in the walls of the steam chests by nuts with copper gaskets, the process of changing over is very simple.

Fig. 6. Throat Transmitter and Head Receiver

Fig. 7. Telephone Rescue Equipment

Mine Recovery Telephone Equipment

The problem of devising ways and means for the protection of human life in mines is probably the most important question before mine operators and the Federal Bureau of Mines today. The laws of practically every state, in which mining operations are carried on, call for regular inspections and many safety regulations, not the least of which, in a number of states, is a section making compulsory the use of telephones underground.

Lately, however, attention has been directed to the urgent need, after an explosion or fire, for some means of instant and continuous communication between those wearing oxygen apparatus inside of a mine and those outside the mine directing the work. In the past, members of the helmet corps have lost their lives where loss of life could have been prevented by a quick means for summoning aid.

The demand for this kind of equipment has been met by the Western Electric Co., which has succeeded in producing a light, serviceable, and simple telephone set for use in rescue work. In developing the apparatus, the United States Bureau of Mines was consulted in order that every requirement of this service might be fully covered.

A man wearing an oxygen helmet, which covers his mouth, cannot use the ordinary telephone transmitter, so the "throat" transmitter has been developed to meet this condition. The transmitter is provided with a soft rubber cup which adapts itself to the curves of the throat and transmits speech practically as well as the standard Bell instruments. The telephone equipment used by the man at the outside or directing end is a standard switchboard operator's set.

The helmet corps is connected with the outside by a small wire cable consisting of two insulated copper conductors covered with a moisture resisting compound. This wire, in 500-foot coils, carried in a leather case fastened to the helmet man's belt, pays out as he advances. As the coils weigh less than 3 pounds apiece, several of them can be carried, and as one is run out another is connected by a plug-and-jack combination. The wire is so wound that it cannot become tangled, and will pay out in whatever position the helmet man may have to assume. The total weight of telephone equipment carried by the helmet man, including one coil of wire, is a little over 5 pounds.

One end of the coil is equipped with an aluminum encased plug which connects with the head receiver and throat transmitter by means of an aluminum encased jack. The other end is equipped with a

similar jack connecting with a plug and cord running to a battery and apparatus box. This box is an essential part of the equipment and must be placed at the point from which the helmet corps is being directed. It contains eight dry batteries mounted in a Patterson screw-type battery holder, and a key, two jacks, and a battery gauge, mounted in a removable compartment. The operator's telephone set is connected to the apparatus and battery box by means of a cord, plug, and jack. The key operates in two directions and has three positions: neutral, right, and left. In the neutral position, the batteries are in circuit; when operated one way, the batteries are disconnected to save current when the apparatus is not in use; while in the other position, the battery gauge is connected across the battery terminals so that the condition of the batteries can be determined. It would be a serious matter to discover that the batteries were too weak for service after the rescue party had entered the mine.

It may be desirable to use a cable for carrying the talking circuit down a shaft or into a slope up to the edge of the danger zone. For this purpose a large, strong box is furnished containing an aluminum reel holding 1,300 feet of strong and flexible twisted pair cable, having a 30-per-cent. Para rubber insulation. A heavy ratchet and pawl are provided to prevent the reel from turning after enough cable has been paid out. Connections with the apparatus box and the coil carried by the helmet man are effected by means of aluminum encased jacks and plugs, while electrical contact with the inside end of the reeled cable is made through collector rings and commutator brushes connected to a jack.

The entire outfit has been constructed with a view to providing serviceable telephone communication during mine rescue work, and if it is kept in hand as part of the rescue equipment at mines it will be the means of rendering such work less dangerous.

Approved Electric Mine Lamp

A short time ago the Bureau of Mines approved an electric mine lamp which was to be carried in the hand, and on June 21 approved the Hirsch portable electric mine lamp which is worn on the cap as shown in Fig. 8.

At about the time the lamp was approved, word was received from

Fig. 8. Cap Lamp and Battery

the Colorado Mining Department that the legislature of that state had just passed an act making it compulsory upon the mine owners of the state to use electric lamps if the lamp is approved by the United States Bureau of Mines.

The "Proto"-Fleuss-Davis Apparatus

The first practical breathing apparatus designed to permit entering noxious gases after a mine explosion or during a fire was invented 35 years ago by Henry A. Fleuss. The Siebe, Gorman & Co., Ltd., of London, England, sole manufacturers of this apparatus, are represented in this country by Mr. H. N. Elmer, 1122 Monadnock Building, Chicago, Ill. The "Proto"-Fleuss-Davis apparatus has been improved from time to time, and is an excellent self-contained breathing apparatus.

The oxygen cylinders are carried on the back and the breathing bag on the chest so their weights balance. By means of a curved neck-piece the valve controlling the oxygen supply is brought to the front, in sight and within reach of the operator, leaving nothing on the back that could be damaged by accident.

By means of a flexible pressure-gauge tube and a pressure gauge carried in the pocket of the breathing bag in front, the pressure in the oxygen tanks can be ascertained at any time, and the movements of the wearer regulated accordingly.

If, however, the pressure-gauge tube should become injured or leak it may be shut off entirely. Owing to the simplicity of the apparatus no test is required beyond noting that the caustic soda is in good condition and that the joints are tight, and that the by-pass and relief valve work properly. Any dangerous leakage is at once detected by the deflation of the breathing bag.

TRADE NOTICES

Improved "Victor" Gate Valve. The Lunkenheimer Co., with their improved "Victor" gate valve, have produced a valve guaranteed to withstand extreme conditions of pressure and superheat. The valve is made entirely of brass, or iron-bodied brass mounted. They are also made in sizes ranging from 1½ to 16 inches, inclusive, and in two combinations, one for pressures up to 300 pounds, the other for 350 pounds. The valves are made in two forms, one has a stationary stem, the other with outside screw and yoke. Either pattern of gate valves can be packed under pressure when wide open. All parts of the valves are heavy, but compact, with the strain on the connecting pipe due to the weight of the valves minimized. The valve is unaffected to any extent by expansion or contraction. The by-pass used on the Victor valve is not separate from the valve, but is cast integral with the

body. This additional metal tends to strengthen the valve body.

Forty-Ton Electric Locomotive. The Timber Butte Milling Co., Butte, Mont., has recently put into service a 40-ton Baldwin-Westinghouse electric locomotive. This locomotive is being used for hauling materials to the concentrator and the concentrates to points where switching connections have been established with the Chicago, Milwaukee & St. Paul, Northern Pacific, Butte, Anaconda & Pacific, and Great Northern roads.

The Link-Belt Co., of Chicago, has orders for a steel tipple and preparing and sizing plant for Independence Coal and Coke Co., of Salt Lake City, for mines located at Kenilworth, Carbon County, Utah, the first modern tipple equipment in the state of Utah; a steel head-frame and tipple equipment for the Jedd Coal and Coke Co., Jedd, W. Va.; a Mono-bar chain retarding conveyer and screening plant for the Asher Coal Mining Co., Knoxville, Tenn., for mines at Amru, Ky.; an order for reconstructing the Consolidated Coal Co.'s No. 14 tipple at Staunton, Ill.; and a large rescreening plant for the Royalton No. 1 mine at Royalton, Ill., of the Franklin Coal and Coke Co., of St. Louis. A. J. Sayers, engineer in charge of tipple and washery work for the Link-Belt Co., has recently returned from a 4-weeks' trip through the coal mining district of Utah.

Pittsburg Office.—B. S. Rederer has opened an office at 518 Park St., Pittsburg, for the sale of power plant equipment. Among other firms represented by him are The Brownell Co., of Dayton, Ohio, manufacturers of high-class engines.

New Manager.—The Goulds Mfg. Co., Seneca Falls, N. Y., announce the appointment of Mr. F. Z. Nedden, of London, Eng., as engineer in charge of the centrifugal pump department. Mr. Nedden is a graduate of the University of Berlin, has had extended practical experience in German machine shops and has made a special study of high-lift turbine pumps.

New Tipples.—The Roberts and Schaefer Co., of Chicago, have a contract with W. W. Keefer, president of the Pittsburg Terminal Railway and Coal Co., and also of the Millburn Coal and Coke Co., for building a steel tipple at Keeferton, W. Va., at a cost of about $30,000. It will be equipped with the Marcus combination screen and picking conveyer. The Peacock Coal Co. also have contracted for a $25,000 steel tipple in which the Marcus equipment is likewise to be used.

Centrifugal Pump Bulletin.—The A. S. Cameron Steam Pump Works have issued a bulletin on their double-suction, volute, centrifugal pumps. Besides the various illustrations and descriptions, there is much detailed information about the merits of this new pump, which has an enclosed impeller and a horizontally split casing, allowing ready access to interior parts. The bulletin also contains an efficiency chart, tables of figures on pressures, friction, etc., that will prove of value to engineers.

Hoisting Engines.—The Steubenville, Ohio, Coal and Mining Co., operating the High shaft, are making some extensive improvements, including new steel head-frame, cages, etc. Also are installing a pair of Crawford & McCrimmon Co. (Brazil, Ind.), first-motion hoisting engines. The output will be greatly increased.

Catalogs Received

Ingersoll-Rand Co., 11 Broadway, New York. Ingersoll-Rand Products, 140 pages.

The Goulds Mfg. Co., Seneca Falls, N. Y. Guaranteed Service, 18 pages; Double-Acting Plunger Pumps, 8 pages.

American Safety Lamp and Mine Supply Co., Scranton, Pa. Circular, Delco Safety Water Gauge.

Baldwin Locomotive Works, Philadelphia, Pa. Gasoline Locomotives, 23 pages; Mikado Type Locomotives, 39 pages; Recent Development of the Locomotive, 53 pages.

Sullivan Machinery Co., 122 S. Michigan Ave., Chicago, Ill. Sullivan Cross-Compound Power-Driven Air Compressors, 19 pages; Sullivan Hammer Drills for Quarry Purposes, and Stone-Dressing Tools, 19 pages; Booklet 112, Sullivan Air Compressors, 32 pages.

A. F. Daum Co., Pittsburg, Pa. Circular, Development of Refillable Fuses for Electric Light and Power Circuits.

Henry R. Worthington, 115 Broadway, New York. Worthington Volute Centrifugal Pumps, 62 pages.

Gardner Governor Co., Quincy, Ill. Gardner Duplex Power Pumps, 8 pages.

A. S. Cameron Steam Pump Works, 11 Broadway, New York. Cameron Centrifugal Pumps, 16 pages.

Lidgerwood Mfg. Co., 96 Liberty St., New York, N. Y. Bulletin No. 12, Lidgerwood Electric Hoists, 20 pages.

Albany Lubricating Co., 708-710 Washington St., New York. The Bearing.

Goldschmidt Thermit Co., 90 West St., New York. Instructions for the Use of Thermit in Railroad Shops, 36 pages.

Williams Patent Crusher and Pulverizer Co., St. Louis, Mo. Williams Supplies and Repairs, Folder; Our Infant Grinders, Folder.

Keystone Driller Co., Beaver Falls, Pa. The Keystone Magazine, 16 pages.

Continental Car and Equipment Co., 607 Marquette Building, Chicago, Ill. Continental Dump Cars, 79 pages.

The Improved Equipment Co., 60 Wall St., New York, N. Y. Silica Retorts and Settings for Gas Benches, 23 pages.

Link-Belt Co., Chicago, Ill. Link-Belt Tipples and Equipments for Coal Mines, 40 pages.

John A. Roebling's Sons Co., Trenton, N. J. Damming the Mississippi, 8 pages.

The Ohio Brass Co., Mansfield, Ohio. Circular, Mine Headlights for All Service Conditions.

The Colliery Engineer

Formerly Mines and Minerals

XXXIV—No. 2 SEPTEMBER, 1913 Scranton, Pa.

hetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68

LIBRARY
SEP 3 1913
UNIVERSITY OF TORONTO

A California Coal Mine

"SURE GRIP"

"Sure Grip" is not simply a trade name used to designate our particular brand of Trolley Clamps. It is also an absolute guarantee—it's a fact.

The "Sure Grip" Trolley Clamp is all its name implies.

It is so constructed that, once adjusted properly, it is simply impossible for it to work loose or to drop the wire.

This is but one of the features that has made the "Sure Grip" Trolley Clamps so popular in the mine field. Men in the workings feel absolutely secure when walking along passages where trolley wire is strung. They know that the wire **cannot** work loose and hang down, endangering their lives.

Made in all sizes from 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine and Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah (Office Atlanta) Cleveland
San Francisco Los Angeles
Seattle Portland, Ore.

COPYRIGHT, 1913, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXIV—No. 2 SEPTEMBER, 1913 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.
ESTABLISHED 1891

INTERNATIONAL TEXTBOOK CO., PUBLISHERS
T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer
RUFUS J. FOSTER, Vice President and Managing Editor
EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor
CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second class matter
Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

CIRCULATION THIS NUMBER 13,000

TABLE OF CONTENTS

Editorial—
Notes—Mining Machinery Exposition—The Mining Malaise—The East Brookside Disaster—The Girard Estate—The Lighting of Colorado Mines—The American Mining Congress . . . 65
Personals . . . 68
Alabama Coal Operators' Association, by Wm. Z. Price . . . 69
Waste in Coking, by Guy E. Mitchell . . . 74
A Practical Man's Way . . . 76
Coal Mining Machines, by Wilbert A. Miller . . . 77
Miners' Field Day . . . 80
Ventilating Mines and Removing Gas, by Dr. J. J. Rutledge . . . 81
Relation of Subsidence to Packing, by George Knox . . . 87
Production of Stone Dust in Collieries . . . 90
Correction . . . 90
Complete Mine Maps . . . 91
Report of English Explosions in Mines Committee, by James Ashworth . . . 92
Old Friebergers in America . . . 93
Lignite Mining at Hoyt, Tex. . . . 93
Electrically Driven Compressed Air Plant . . . 94
Carrying the Meridian Underground, by W. Roberts, Jr. . . . 95
Explosion Proof Motors . . . 96
American Mine Safety Association . . . 96
Moving Pictures as an Aid to Mine Accident Prevention . . . 97
How to Handle a Dry or Dusty Mine, by David Vivian . . . 99
The Brookside Mine Disaster, by William Z. Price . . . 101
Care and Lubrication of Air Compressors . . . 104
Notes on Mines and Mining . . . 105
Employes Magazine . . . 107
The Letter Box—
Conveying Sand by Compressed Air—Nova Scotia Examinations—Shaft Sinking in Wet Ground—Test of Safety Lamps—Acetylene Lamp Difficulties—Is Anthracite Dust Explosive? . . . 108
Obituary—
Richard Newsam—George Harrison—H. A. Nelson . . . 110
Advance in Permissible Explosives . . . 111
Practical Talks on Coal Mining—
Mine Ventilation, 112—Mechanics of Mining, 114—Electricity in Mines . . . 116
Book Review . . . 118
Prize Contest . . . 119
Birds in Coal Mines . . . 122
Examinations—
Fire Boss, Birmingham, Ala., January, 1913 . . . 123
New Mining Machinery—
The Eureka Timber Hook—New Mine Section Insulator—Improved Automatic Water Gauge—McKesson-Rice Screenless Sizer—Rotary Power Pump . . . 126
Trade Notices . . . 128
Catalogs Received . . . 130
Squibs—
Siberian Collieries, 73—Centimeter-Gram-Second System, 76—Ammonia Bombs for Forest Fires, 80—Blight-Killed Chestnut, 86—Waste from Saw Mills, 94—Waste in Coking, 96—Suppose Miner, 98—Virginia Coal, 111—Oil Signs, 125—Silk from Wood . . . 125

WHEN the coal department of the D., L. & W. Co. issued for its employes a book showing illustrations of causes that led to accidents in anthracite mines, and means for their prevention, an excellent idea was practically applied. Mr. Thos. Lynch, President of the H. C. Frick Coke Co., and other coal companies allied with the U. S. Steel Corporation has improved on the D., L. & W. idea, by using moving pictures for the same purpose, as described on another page of this issue.

WHEN all labor leaders, mine managers, and legislators realize that the prime object of a mining law is to conserve the lives and health of the mine workers and protect the property of the mine owners, there will be fewer "damphfool" provisions in the various state mine laws. As long as attempts are made to make a mine law subservient to either side in labor disputes, and as long as politicians use the formation of such laws to further their political interests, it will be difficult to attain perfection.

MOST coal mine officials of this generation are broad-minded men, who not only exchange ideas with their immediate neighbors, but who welcome opportunities to have their successful methods described for the benefit of their colleagues in all parts of the country. They are the men who succeed and become prominent in the industry. They not only work out original solutions to mining difficulties, but they take advantage of the ideas of their colleagues, and recognizing their obligations, they cheerfully make known their own successful methods. The great advances made in safe and economical coal mining during the past 20 years have been more largely due to these broad-minded mine officials than to any other cause.

Mining Machinery Exposition

IT IS to be noted that the officers of the American Mining Congress realize that economic and progressive mining must come through the increasing use of machinery in mines. Realizing that at past conventions of the Congress the mining machinery manufacturers labored under difficulties in obtaining suitable nearby quarters to show and display their fabrications, it is

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

proposed to hold an Industrial Exposition in connection with the meeting in Philadelphia commencing October 20. and continuing through the week. As this convention is expected to be the largest ever held it will be an excellent opportunity for manufacturers and operators to become acquainted. Sufficient enthusiasm has been shown by manufacturers to warrant the officers of the Congress in engaging Horticultural Hall for the occasion.

The Mining Malaise

THE editor of *The Mining Magazine*, London, Mr. T. A. Rickard, can deliver a swift kick, or punt a wordy goal as surely as the next one.

In a recent editorial under the caption "The Mining Malaise" meaning "Mining in Bad," he has this to say: "The reckless promoter or the tricky director cannot do much unless he finds a complacent engineer to give technical verisimilitude to his oblique performance."

The East Brookside Disaster

THE greatest mine disaster, so far as loss of lives is concerned, that has happened at a colliery of the Philadelphia & Reading Coal and Iron Co., in its history of over 40 years as the largest anthracite mining company, occurred at the East Brookside colliery, Schuylkill County, Pa., on August 2.

As will be noticed, from an account of the accident on another page, there is an element of mystery connected with the cause. That it was a gas explosion is the most tenable supposition, but the strange fact remains that there are none of the usual evidences of a gas explosion apparent at or near the scene of the disaster.

This fact with the positive knowledge that the mine was one of the best ventilated in the region, and that no abnormal quantities of gas were previously encountered in any of the extensive workings, has offered to the many expert mining men on the ground a perplexing problem in their efforts to arrive at a positive cause.

As was natural in such cases, every effort of the officials, both of the state and the company, was first directed to the recovery of the bodies. At the same time, in clearing away the debris, constant watch was kept for any evidence that would help locate the cause.

It is possible that no positive reason for the accident will be found, but if hard work, research, and liberal expenditures of money will solve the mystery, Vice-President and General Manager Richards will see that all are forthcoming.

The Colliery Engineer as soon as possible was represented at the mine by one of its editorial force, who was given every opportunity by Mr. Richards and his subordinate officials to investigate matters. He was not only furnished with verbal descriptions by state and company officials, but was given access to the mine, where the rescue corps was at work, clearing up the fall and searching for bodies, and had an opportunity to personally see the conditions.

The Girard Estate

THE Girard Estate, one of the most valuable pieces of coal property in the world, lies in Schuylkill and Columbia counties, Pennsylvania, and is operated by leases to the Philadelphia & Reading Coal and Iron, Lehigh Valley Coal, Susquehanna Coal, W. R. McTurk Coal, Harleigh-Brookwood Coal, and the Oxford Coal companies.

Mr. James Archbald, Jr., engineer of the estate, in his annual report states that the quantity of coal produced from the Girard Estate in 1912 was 2,215,102 tons, a decrease of almost 200,000 tons below 1911. Of the shipment for 1912, 21 per cent. was reclaimed from culm banks, which is the most reclaimed in any year since 1903, when 465,000 tons or 31 per cent. of that year's shipment came from the banks.

Since 1889, over 3,000,000 tons of coal have thus been reclaimed. The average royalty on coal reclaimed from the coal banks has varied considerably, depending entirely on the quality of the banks worked at the time. In 1912 the royalty was 19.37 cents per ton as against 34.8 cents for fresh mined coal. It must be understood that the latter is an average as the large sizes bring greater royalty than the smaller ones.

The average working time last year, of all the operations on the estate was 237 days or 79 per cent. of full time, which was high, in view of the fact that there was a total suspension of 44 working days in April and May.

The proving of coal on the lands of the Girard Water Co. was begun in August, 1910, and after several hundred drill holes had been put down and 128 shafts sunk, the deepest 32 feet, a lease covering most of the coal thus proved was made out to the late Baird Snyder, Jr., for a term of 16 years, the lease expiring December 31, 1928, but no mining operations which will affect the watersheds of the Water Company will be permitted until other sources of water supply have been secured.

The Lighting of Colorado Coal Mines

SECTION 133 of the new Colorado coal mine law reads as follows:

"After the first day of October, 1913, only electric lamps shall be used in the coal mines, except in places generating gas, or noxious gases, where an approved safety lamp shall be supplied for each working place for testing purposes, and all lamps shall be the property of the owner and shall be maintained in good condition; they shall be kept in a special room at the surface, and carefully examined when delivered to the underground employes. Provided, that upon that date there sl have been produced and placed on sale a practicable · efficient elec-

tric lamp which shall have been approved by the United States Bureau of Mines, as an electric light having such qualifications."

In mines generating considerable quantities of fire-damp, the matter of expense, and even of a less convenient though more brilliant light, should not be counted, if by the adoption of such a light human life may be conserved.

As a lamp for testing purposes, the electric lamp is useless. Therefore, the new Colorado law required that in gaseous mines an approved safety lamp for testing purposes must be supplied for each working place in addition to the electric lamp.

This is a nonsensical requirement. If the working miners were all capable of detecting gas by the use of a safety lamp, and they would all frequently use their safety lamps for that purpose, they would know when their working places became unsafe and could take precautionary action.

If a safety lamp must be used in connection with the electric lamp at each working place, a new element of danger is introduced. Either the safety lamp must be kept continuously burning during working hours, or the lighting of it is an element of great danger. If kept continuously burning, the miner will naturally place it at some distance from the point at which he is working, will use the more brilliant electric light, pay but little or no attention to the safety lamp, and the latter, if a good testing lamp, is liable to fill with gas and explode. If it is of a type that becomes extinguished in a gaseous atmosphere, it is liable to go out, and then the dangerous operation of relighting it is likely to occur with disastrous results.

The Colorado legislature, and those responsible for this section of the law, do not seem to realize that it is impossible to inject caution and intelligence into mine workers by legal enactment.

If the section provided that in gaseous mines, in connection with the use of electric lights, additional examinations of working places should be made by the fire bosses during working hours, instead of requiring each miner, no matter how incapable he may be, to act as a fire boss, it would be a more rational measure.

American Mining Congress

OFFICERS of the American Mining Congress and local committees anticipate a larger number of delegates and members than ever assembled at a former convention.

Secretary Callbreath promises it will not be altogether an eastern affair, as western men are coming East in special trains to discuss irritating questions that are more or less national in scope.

When conventions have been held in the West, local subjects usually dominated the proceedings, while the spread-eagle speeches and pronunciamentos usually surfeited those from the East.

When conventions were held in the East, matters pertaining to coal were the principal subjects, so that a westerner could hardly mention irrigation without several easterners notifying him that all former irrigation schemes must be liquidated before new ones could be entertained. For the first time probably in the history of the American Mining Congress the East and West have subjects of mutual interest to talk over. Among these are taxation of mining properties and outputs by misguided and unfortunate legislators, who are so ignorant on the subject of mining they are unable to pick out the goose that lays the golden egg in each mining state.

Arizona, Colorado, Michigan, and Pennsylvania have been taxed in a way which negatively affects the industry in those states. Pennsylvania is better situated to stand the burden of taxation, for the elasticity of its product is such that the consumer will be the one taxed.

The other states, being metal producers, have their product regulated by competitive production, the law of supply and demand, and the selling price in Europe. Colorado miners claim they are subjected to a double tax, while anthracite miners have three kinds of taxes.

The people of the Northwest want a definite Alaska policy; the people in the East a definite Mexican policy; and all a land policy which shall be just.

The smelter-fume problem needs discussion according to the views of California, Montana, and Utah delegates. In the East, while we have the largest smelters in the world, we pay no attention to fume and at the same time defy any western farmer in the states mentioned to show without irrigation more luxuriant vegetation than exists in the vicinity of the eastern smelters. In the editor's opinion when vegetation is injured by smelter fume it is a sickly growth. Undoubtedly some will take exception to this statement but we think it will stand the criticism. California will have something to say on hydraulicking and the debris question. While it is a purely local affair, if they want a mining engineer on the commission, where now all are Army Engineers, they should have one. Should people in the East be inveigled into the controversy they would be found utterly opposed to the pollution of streams in any manner. It spoils the fishing. The metal interests of the West are to be represented and there is a tentative plan to have a gold mining camp in full operation with a mill crushing ore. A number of the large coal companies are said to have negotiated space to show mining men and the public what they are doing in behalf of their men. First-aid crews, rescue cars, helmet corps, and possibly the United States Bureau of Mines will be on exhibition.

The proposed system of leasing mineral lands by the Federal Government will receive its share of comment, also there will be an appeal for the revision of the United States Mineral Land Laws.

If the tentative program is adhered to this meeting of the Congress will go down on the minutes as having been the first one where mining men from all sections of the United States had subjects for discussion affecting the entire industry.

PERSONALS

William Mangan, outside district superintendent for the Lehigh Valley Coal Co., at Wilkes-Barre, Pa., has resigned to become superintendent of the O'Boyle Coal Co., Sugar Notch, Pa. He will be succeeded by John Reidlehuber, outside foreman of the Centralia colliery.

A. D. MacFarlane, resident engineer at the Bayview mine of the Tennessee Coal, Iron, and Railroad Co., has accepted the position of chief engineer of the La Follette Coal, Iron, and Railroad Co., at La Follette, Tenn.

R. E. Gannon, of Cairo, Ill., has been elected president of the Illinois and Wisconsin Retail Coal Dealers Association.

Governor George W. Clarke, of Iowa, has reappointed J. E. Jeffreys, of Albia, R. T. Rhys, of Ottumwa, and Edward Sweeney, of Des Moines, as mine inspectors of the first, second, and third districts, respectively. The term is for 4 years.

J. W. Powell, superintendent and mine manager of the Columbia Coal and Coke Co., has severed his connection with that company owing to the indefinite suspension of operations at their mines. He is now visiting in the East among the anthracite mines.

F. C. Cornet, mining engineer, has given up his office at Charleston, W. Va., to accept the position of general manager of the Elkhorn Gas, Coal, and Mining Co., at Melvin, Ky. This company has just been incorporated, in West Virginia, by Messrs. Schlesinger & Weeks, of Milwaukee, Wis. The new company replaces the old Beaver Creek Fuel Co.

William Grelley, well known in eastern Ohio and West Virginia coal regions, has resigned his position with the West Virginia Pittsburg Coal Co., at Wellsburg, to take charge of the Buckeye mine near Flushing, Ohio, as superintendent. John T. McMahon, formerly with the United States Coal Co., at Bradley, Ohio, has succeeded him with the West Virginia Pittsburg Co.

T. A. Jackson, of Curtisville, Pa., is now traveling for the Keystone Lubricating Co., making his headquarters at Springdale, Allegheny County, Pa.

C. A. De Saulles, Yale 1899, Sheffield, has been elected to membership in the Mining and Metallurgical Society of America. His office address is 165 Broadway, New York City.

W. S. Thyng, M. E., has concluded his services as secretary of the Northwest Bureau of Mines, having headquarters in the Columbia Building in Spokane, and has opened an office for the general practice of mining engineering.

Malcolm MacFarlane, of Towanda, Pa., has been appointed assistant mine inspector to H. B. Douglas, inspector of mines of the New York Central & Hudson River Railroad Co., with headquarters at Philipsburg, Pa.

C. T. Morgan, of Wilkes-Barre, has been appointed superintendent of the Morris Run Coal Co., Tioga County, Pa., to succeed Malcolm McDougall, resigned.

Lee Ott, general superintendent of the Davis Coal and Coke Co., has resigned to become a member of the board of control of the state of West Virginia, a post tendered Mr. Ott by Governor Hatfield some weeks ago. Mr. Ott's resignation became effective August 1. He has been connected with the Davis company for 20 years.

President Fitzgerald, of the Davis Coal and Coke Co., has announced several changes among the officials. W. W. Brewer of the Weaver plant, has been made superintendent of Pierce operations to succeed Charles Connor. Mr. Brewer will be succeeded by H. H. Harrison of the Elk Garden plant, as superintendent of the Weaver operations, while J. E. Ott, mine foreman at Dartmoor, succeeds Mr. Harrison as superintendent at Elkhorn Garden.

Harry Sharp, formerly of the Youghiogheny Coal Co., has been appointed assistant to the general superintendent of the Davis Coke and Coal Co., with headquarters at Thomas, W. Va.; Charles Bashore has been named to succeed M. L. Garvey as superintendent of the Thomas plant, Mr. Garvey having resigned.

L. D. Huntoon, E. M., 115 Broadway, New York, is eastern representative of the Stearns-Roger Mfg. Co., Denver, Colo. His professional work will be continued as in the past.

F. P. Bayless, E. M., who for some years was located in the vicinity of Trinidad, Colo., has been appointed assistant general manager of the New River Collieries Co., with office at Eccles, W. Va.

Iva M. Morgan, Fairmont, W. Va., has been appointed auditor for the Elkhorn Fuel Co., with offices at Beaver Creek, Ky.

William Clifford has sold his fan works at Fort Pitt, near Jeannette, Pa., to the Ely Brass Foundry Co., of Pittsburg. It is stated that Mr. Clifford will go to England as soon as he can arrange his affairs, and make his home there.

Truman M. Dodson at present superintendent of the Dodson Coal Co., at Morea and Kaska, has been elected president of the Locust Mountain Coal Co., to succeed the late Baird Snyder, Jr.

William Underwood, division superintendent of the Mahanoy Division of the Lehigh Valley Coal Co., resigned that position, effective July 31. He is succeeded by Thomas R. Jones, of Hazleton.

Dr. W. R. Crane, Professor of Mining in the Pennsylvania State College, has just returned from Alaska, where he has spent the past year investigating the coal resources of that territory.

W. L. Affelder resigned as superintendent of the Bulger Block Coal Co. in Pittsburg, Pa., field to accept the position of general superintendent of the five plants of the Bessemer Coke Co. The resignation took effect on August 23, and Mr. Affelder took up his new duties on the 25th. Mr. Affelder's office will be in the Oliver Building, Pittsburg, and his time will be spent between there and the several plants.

COAL MINING & PREPARATION

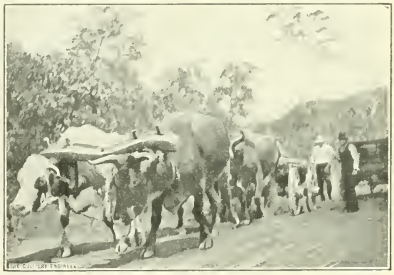
Alabama Coal Operators' Association

The Fifth Annual Session, Held at Marvel, Alabama—An Account of the Proceedings With Abstracts of Some of the Papers

By William Z. Price

THE annual meeting of Alabama coal mine officials, held under the auspices of the Alabama Coal Operators' Association, at the Marvel mines of the Roden Coal Co., at Marvel, Ala., on July 26, 1913, was probably the most successful and enjoyable meeting the Alabama operators have ever had.

ENTRANCE TO MARVEL TIPPLE



HAULING MINE TIMBER

Between 350 and 400 operators, mine officials, state mine inspectors, United States Bureau of Mines representatives, and invited guests left Birmingham on a special train over the Louisville & Nashville Railroad, at 9 A. M., arriving at Marvel, 31 miles distant, about 11 o'clock.

Upon the arrival of the party at Marvel, they proceeded at once to an inspection of the mine operations, the town, and the commissary.

The tipple was designed by Thornton Brothers, engineers, of Birmingham, who also superintended its construction. It is a modern tipple with a capacity of 4,000 tons a day. The coal, after being dumped into the hopper at the top, is fed by means of a shaking feeder on to shaking screens, both made by Roberts & Schaefer Co. There are four sizes of coal prepared, two sizes of lump, and nut and slack coal. The slack coal goes to a Montgomery jig washer and is then elevated to the top of the washery, thence it passes over elliptical shaking screens and is conveyed to the bins for loading. The washer has a capacity of 800 tons per day.

The Marvel mines operate the two Cahaba seams, the Clark and the Gholson. No. 1 mine workings are entirely in the upper or Clark seam, and No. 2 mine in the Gholson seam, 28 feet below. The mines are located in the northeastern part of Bebb County, on the Southern Railroad, between Gurnee Junction and Blocton. The route is over the Birmingham-Marvel Railroad, which uses the Southern Railroad tracks from the junction to Blocton.

The Clark seam in No. 1 mine is about 40 inches thick. The roof is slate and sandstone and is very good. The coal is shot from the solid with black powder. The mine is ventilated by the same fan as No. 2 mine (a No. 2 Sirocco). The fan is encased in a concrete building and is driven by an electric motor. The intake is the slope, and the air is then conducted through the cross-entries on the split system. The mine cars are distributed and gathered by mules and hoisted by a 24″ × 48″ double hoist Hardie-Tynes engine. The mine is naturally dry, so cross-entries are equipped with water lines and are wet down with a hose. The mine has, in addition to the second opening prescribed by law, an escapeway through to No. 2 mine. This mine lying directly over No. 2 is worked on identically the same plan as the seam below, entries and rooms being driven over those beneath, thus making the pillars columnar.

No. 2 mine, operating the Gholson seam, has a roof like the one above. This seam has an average thickness of about 38 inches. The two mines employ together about 300 men.

The average production is about 1,400 tons a day. In 1912 the two mines in 245 working days produced over 260,000 tons at an average cost

of 55 cents per ton. All the coal is mined by pick.

The two mine openings are almost side by side, the one being about 20 feet below the other and about 10 feet to the right. The mouth of each slope is faced with concrete, and this is continued for a distance of about 200 feet inside.

From the tipple, the party inspected the town, which is of about 800 population. The streets, houses, and other buildings are lighted by electricity. The houses are of the bungalow style typical of the southern mining camps; water is furnished the houses free of cost, and electric light at the rate of 25 cents per lamp per month, regardless of the amount burned. The rents are from $3.75 per month for a two-room house to $9 a month for a six-room house. The water system in operation is a splendid one. From a reservoir supplied by mountain springs, 1½ miles distant among the mountains, the water is pumped into a concrete standpipe or reservoir located on the hilltop in the center of the town; from there water is furnished with a strong force to every house and also to the fire plugs which are systematically arranged each several hundred feet.

Strict attention is paid to sanitation at Marvel. Garbage men make daily rounds with their carts and thus keep streets and premises clean. Schools are provided for children of both races. At its own expense the company has erected a large two-story school building with four class rooms and an auditorium for the white pupils. The heating is by means of the hot-air system, and fresh air is furnished continually by a 5-foot mine fan. A new building for colored pupils will be erected which will also be modern and well equipped. The school term is 9 months and is run at a cost of $3,600 per annum, of which amount only $600 is furnished by the state.

The party then went to the commissary, which is a model mercantile establishment screened throughout and equipped with electric fans. Every necessary department of a complete store is represented, each under the supervision of a competent salesman. The meat market in the rear, with its screened protection from flies, is well worth imitation. A soda fountain at the entrance was kept busy supplying the demands of the crowd.

From the commissary the party proceeded across the railroad tracks to the auditorium which is arranged and used for religious services, lectures, concerts, and moving picture shows. It is supplied with seats for accommodating about 600 people. The whole investment is close on to a half million dollars, and the income at present is from $12,000 to $15,000 a month above expenses, so the plant will pay for itself at that rate in a very few years.

The meeting in the auditorium was opened by George F. Peters, president of the Southern Coal and Coke Co., of Maylene, Ala., who acted as chairman in the absence of the president, G. B. McCormack.

The United States Bureau of Mines was represented by Dr. J. J. Rutledge, L. M. Jones, E. B. Sutton, and J. M. Webb. Mr. Webb opened the program with an interesting reel of moving pictures showing the explosion of coal dust in the steel tube at the Pittsburg station and the methods of rescuing injured men from mines where a disaster had occurred and the application of the pulmotors and artificial respiration. Later in the program two reels of pictures were presented entitled "The Preparation and Dispatch of Men and Rescue Car to An Explosion," and "The Miner at Work," the latter beginning with his descent in the cage and closing with the coal he mined at his working place being loaded into the railroad cars at the breaker.

Frank H. Crockard, vice-president of the Tennessee Coal, Iron, and Railroad Co., then read a valuable paper on "What a Coal Operator Can Do to Provide for the Welfare of Employes and Their Families." Mr. Crockard subdivided his subject into five parts, housing, food, health, education, and recreation. He exhibited numerous drawings to illustrate various sanitary agents to which he referred, one, a manure burner, being a duplicate of those used in the Panama Canal Zone, where sanitation is perfected. He took up in general the proposition of model camps, the handling of the necessaries of life, the drinking water in the schools, the proper drinking methods to employ, and the heating arrangements of the school rooms. In speaking of the fly as a source of disease, he said a much more efficient method than the "swat the fly" scheme must be employed; he said "remove the cause and the effect will soon disappear." He further stated that inviting and attractive homes were not only profitable for the workers but for the corporations as well. He laid particular stress on bath-house conditions, and said that although the first cost looked exorbitant it proved the cheapest in the long run. Mr. Crockard is contemplating revising his paper and having it distributed in pamphlet form among the Tennessee company's mining camps.

B. F. Roden, the president of the Roden Coal Co., then read an instructive paper on "The Commissary, Its Indispensability and Purposes." He said in part: A mining company spends thousands of dollars in purchasing and equipping a property; it thus gives employment to large numbers of men. Is there any reason why the business of selling necessities and luxuries to the population thus created, with consequent profits, should be turned over to outside parties? I see no reason if the store is properly conducted.

Give your customers full weight and good value at a reasonable profit above handling on the investment and do not exact the limit of profit your customer will stand; let him make something on the trade, then both buyer and seller are satisfied.

Commissary trade is largely on staples, so some profit must be made on these, if any is to be made. Goods should be kept in a sanitary condition.

Courtesy from clerks is due our customers. Do not allow condescension on their part because their work

is cleaner. Salesmanship, not comment, is desired.

To my mind, the practice of paying off daily in store checks, which are redeemable on pay day, is bad. While this saves some clerical work, yet there is quite a loss to the men, by having checks so handy that they spend more than is necessary. There is also a considerable number of these checks which are lost or never redeemed. Should these checks also be interchangeable it promotes gambling and drunkenness.

Aside from decreasing their value in the minds of the men, it gives an opportunity for the speculator, who can buy these checks for from 60 to 80 cents on the dollar, to purchase goods in the store at way below cost and sell to the employe for less than any competing merchant can buy. Suppose sugar or any of the staples sold in the store could be bought at from 60 to 80 cents on the dollar; these could be resold at a good profit at much below cost. This creates the idea in the minds of your men that commissary prices are too high; since this speculator can afford to sell the same articles at 20 per cent. less than your price. This practice puts a legitimate competitor out of business and places a premium on the speculator. It is also a boon to the bootlegger.

At some mines the superintendent, store force, and office force buy checks at a discount to pay their store bills; this justly creates dissatisfaction among those not allowed to do the same thing. I realize that the boarding houses must have some means of securing their board money. At Marvel we handle this by having each boardinghouse keeper turn in to the office her charges against boarders; this amount is charged the men and credited to the boardinghouse keeper. They then draw checks, bearing their name, instead of using the boarder's checks.

In many families where the man is improvident or a heavy drinker, though he may be a good worker when sober, the commissary prevents hunger and want. His wife can always draw a check, if he has any time in the office. Even should there be a bimonthly pay day, his earnings would be spent in a day or two, leaving nothing for food for the remainder of the week. Many of you have heard wives and mothers say that the commissary has been a blessing to them. This ability to secure

Standpipe at Marvel

food and clothing, if the husband works even a few days a week, lessens the loan-shark evil.

Much time is saved to the busy housewife by having the store on the department plan.

As a rule, the quality of goods in the commissary is better than in the small competing store. This is made possible by the mining companies buying larger quantities per month, thus maintaining fresh supplies. There are certain lines of perishable merchandise which the small store doesn't keep because of small or no profit; bread, meats, vegetables, fruits, ice, pure candy, fish, fresh eggs, etc. Of course, some of the companies are near farming districts or towns, which enables their men to secure these things outside of the commissary. Others, the majority of mines in fact, are distant from farming sections or towns. Unless the commissary provides these articles, the men must do without.

Commissaries pay no rent, do no advertising, should have no losses on bad credits, and have small delivery charges, all of which cost usually from 8 to 10 per cent. of the gross profit; they are thus enabled to give goods of same quality, at lower prices, than competing stores having same freight rates.

The employer gets many benefits from his commissary. It is a means of getting acquainted with the men, and by giving a square deal, breaks down that old idea that the mine owner has no interest in them, other than what he can make out of them. He can make his store prices one of the attractions of the town.

Garnishments would swamp the companies if they did not have their own commissaries to provide the necessities. A garnisheed man is always on the move. He seems to get the habit. This point is so noticeable that many railroads discharge the chronic garnishee.

Now for a few points for both employer and store managers on store methods.

Sell your coal at a profit—lose your old idea of the commissary as your profit maker.

The Federal Census Report for 1909 shows that the Alabama mines, not making coke, only made 1.5 per cent. on the capital invested. This is ridiculous, especially in a short-lived and hazardous business.

The same report showed other lines of business making from 8 to 15 per cent. net. The coal-mining business is a legitimate business selling a necessity, so why not secure a reasonable return on your invested capital.

This report is all the more serious when it is noted that even the small profit spoken of above did not include any allowance for depreciation on mines or equipment. On the other hand, the incomes from stores and house rents were not included.

This clearly shows where the profit has been made, if any. Is this necessary or desirable? I think not.

Display your goods. Counter show cases are silent salesmen and big earners. Do not let your goods get shop worn. Sun, flies, dust, and much handling consume quite a little profit, as no one wants shopworn goods. Have a clearance sale at least every season, as it does not pay to

carry over the majority of season goods. This is particularly important in the shoe department, as styles change and men are quick to learn the latest.

If the management requires a certain per cent. of profit on each year's business, it is only natural that the commissary manager should prefer to inventory old stock at full value, rather than to sell below cost, thus making a poorer show. Often a new manager finds himself saddled with a quantity of old stock. If he cleans up this, his first year's earnings may possibly show no profit; yet, the owner is the gainer, as this old stock decreases in value rapidly after the first year.

Do not look so much at the per cent. of earnings as compared to sales, but lay more stress on the total net profit. Very often, a reduction in price will increase the volume of sales, so that there is a greater profit on the year's business. This is the department-store method.

Do not ask your superintendent, mine foreman, or office force to solicit business. Have it distinctly understood that there is no compulsion to trade in your store. A man's place in the mine must not be dependent, either directly or indirectly, on his trade.

Encourage salesmanship by keeping separate records of each clerk's sales, and pay him accordingly. By this method the good men don't have to average with the lazy clerk, and you can weed out the latter. Cash registers protect honest clerks and the owners from the dishonest clerks. Educate your customers, by your prices, to buy in bulk, not for each meal.

Let us all be open to new ideas. Search for new devices which will lessen the labor and legitimately increase profits.

In conclusion, I would like to emphasize that the store is a necessity at a large number of our mines; but, it must be conducted in a broad-minded manner, according to present-day ideas.

L. M. Jones, of the United States Bureau of Mines, concluded the morning session with a paper on "Prevention of Haulageway Accidents." He said in part:

By consulting the tables of fatal accidents that occur in and about mines, it is found that accidents due to haulage appliances are second in number only to those due to falls of roof and coal.

In this paper I have included under the heading of haulage accidents, the accidents ordinarily given under two classifications, those due to mine cars and locomotives, and those due to electricity. As practically all accidents given under the latter classification occur on the main haulage roads from persons coming in contact with the trolley wire, precautions tending to prevent such accidents may properly be considered in this connection.

In Alabama in 1912, 12 men were killed by tram cars and seven were electrocuted. As there were 121 fatal accidents, the percentages of fatalities due to these two causes are 10 per cent. for cars and 5.7 per cent. for electricity. Two men were killed by haulage ropes and three by railroad cars, so that the total percentage of fatalities from haulage appliances is 20 per cent. of the total.

The installation of manways parallel to main haulage roads and the strict enforcement of a rule compelling the use of these by miners in going to and from their working place would automatically make a large reduction in the number of haulage accidents in entries. These manways should be kept in good condition at all times so that the miner would not be likely to choose the haulage roads in preference, either because of better walking or safer roof. If the manways were illuminated at intervals the miners would much prefer walking in a lighted entry than in one that was not, particularly so when first entering the mine.

Some companies have rules to be followed by the various classes of employes. Copies of these rules are furnished to all employes. The sections of such rules applying to travel in the mine could to advantage be posted at some prominent point outside or inside the mine, or both.

One of these companies has made a remarkable record in decreasing the number of their accidents by taking many precautions underground and by a campaign of education. The deaths from all accidents per 1,000,000 tons mined in 1911 were 1.72 for this company, while for the United States they were 5.48. The deaths from car accidents per 1,000,000 tons mined were .41 for this company as compared with .79 for the whole United States.

In the afternoon session Charles H. Nesbitt, Chief Mine Inspector of Alabama, read an interesting paper on "The Value of a Safety Inspector and Instructor for Each Coal Mine." Mr. Nesbitt said:

"It is probable that no subject throughout the industrial world has received more consideration than that of reducing mine accidents. On this occasion we come face to face to discuss the problem as it concerns the coal mines of Alabama. Great progress has been made from time to time in the mines, and each year we are adding new features and taking steps in the direction indicated. The inauguration of safety inspectors and instructors in the coal mines is of such importance as to be immediately commendable to all of our coal operators. We all doubtless agree that education and supervision are indispensable in all classes of trade where the best results are obtained.

"All industries which employ labor realize that it is very important to have adequate supervision over the entire force, even where life and limb are not at stake. In coal mining, supervision and discipline are difficult because the workmen are segregated singly or by pairs in their respective working places, and, unlike mills, factories, and quarries, the foreman or superintendent cannot keep an appreciable number of men under his eye and direction at the same time, making successive and frequent visits to each place in the mine imperative; therefore, in the ordinary coal mines in this district

the mine foreman and fire boss cannot cover the ground and also discharge the numerous other duties incumbent upon them. In coal mining, where the hazard is great, the cost of such supervision is many times offset by increased efficiency which invariably accomplishes the reduction of accidents. I would therefore earnestly advocate that the operators of Alabama each establish a Department of Safety and Instruction, and that, in addition to the mine foreman and fire boss, daily inspections be made of every working place by a person experienced and qualified to teach, and authorized to enforce the provisions of the law for safety.

"In this state in 1912 we recorded 62 fatal accidents at the faces of working places. These accidents were attributable to the following causes; namely, fall of rock, fall of rock and coal, fall of coal, and shot firing. These constituted over 50 per cent. of the total number of fatalities for that year. Upon investigation it was found that a majority of these fatalities could have been avoided if proper instruction and supervision had been given and exercised. Probably in all cases the victims followed their best judgment, which obviously was bad; therefore, it is really necessary that the advantage of experienced direction and supervision of the work should be given to all operations. No better evidence of the value of this system could be cited than the results which have been attained by those Alabama operators who have inaugurated it. Doubtless all of us have taken notice of the considerable reduction in fatalities in and about the mines operated by the companies referred to.

"As long as human muscle and brains are essential to coal mining, just so long will the human element in the causation of accidents exist; and the ratio of avoidable accidents remain directly proportionate to the extent that ignorance, carelessness, indolence, disobedience to rules and instructions, and poor judgment, prevail. How then can we best eliminate or minimize these factors so productive of personal injury to coal-mine employes?

"We have tried placing the responsibility upon the individual, and have found that it did not accomplish the desired ends. As we know, it is a difficult matter to convince the man of poor judgment that he is not as well equipped for his duties as is the man of superior judgment; therefore, the man of poor judgment needs, and will benefit by, the close and constant supervision and instruction which would be obtained by the system I have advocated. It has to be "hammered" into him. While there must necessarily be joint instead of individual responsibility, at the same time there must always be, like unto an effective military organization, some directing head or commander, immediately overlooking the work as it progresses, and intelligently managing the details of it along the line of safety."

This paper caused considerable discussion. Edward Flynn, chief mine inspector of the Tennessee Coal, Iron, and Railroad Co., said in discussing Mr. Nesbitt's paper:

"The vast majority of coal miners will accept things to their own benefit and will not quit their work because discipline for 'safety first' is enforced.

"Accidents are due to the carelessness of officials as well as miners, and 80 per cent. of the accidents are from this cause. Then since 80 per cent. of our accidents are due to carelessness, then 80 per cent. depend on education, and you must educate the miner and the operator to that standard where each works for the safety of the miner. Mining is not as hazardous an occupation as insurance agents would have people believe, and it can be done with less accidents than in other employments; but more accidents occur in coal mines, due to carelessness, than in any of the other employments, and strict supervision and discipline will reduce this carelessness to a minimum.

"There are three classes of miners, (1) the experienced careful miner, (2) the experienced reckless miner, and (3) the unexperienced careless miner. The first class are all right, the third class are amenable to discipline, but the second class cause the most accidents because they refuse to listen to warnings and think they know it all."

Dr. J. J. Rutledge, of the United States Bureau of Mines, concluded the program with a paper on "Coal Mine Ventilation and Removal of Gas," which will be found on another page of this issue.

Between the morning and the afternoon sessions at 1 o'clock there was a barbecue lunch in the auditorium of the new school house.

In closing, resolutions were adopted as follows: "Whereas, the Roden Coal Co. has been untiring in its efforts to promote the pleasure, comfort, and instruction of the representatives of the Alabama Coal Operators' Association at the ideal mining village of Marvel,

"Therefore, be it resolved that the hearty thanks of this association be tendered Mr. B. F. Roden and other officials of the Roden Coal Co., and all those whose efforts are responsible for our most pleasurable and instructive day."

Siberian Collieries

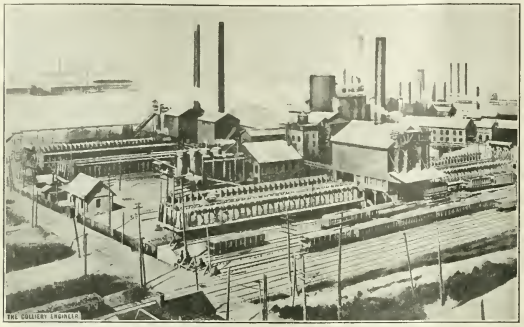
The following proposition was presented by the collieries of the basin of Scheremkovo, near Irjiustsk, in Siberia, to the Russian Government. It is proposed to furnish 30,000,000 poods of coal (540,000 tons), providing that a special tariff of $\frac{1}{300}$ of a copek ($.0075) per pood-verst is established for the transportation of the coal by rail. This is equivalent to a freight rate of $.000025 for carrying 36 pounds two-thirds of a mile, or 2 mills per ton per mile. It does not seem that the bid will be accepted, inasmuch as the proposed tariff would be ruinous for the railroads and, besides that, the transportation of this coal a distance of more than 5,000 kilometers would not be made without difficulties. It is, however, interesting to mention this bid, as an indication of the importance of the Siberian collieries.

Waste in Coking

Savings Possible by Using By-Product Coke Ovens Instead of Beehive Ovens
Recent Increase in Number of By-Product Ovens

By Guy E. Mitchell*

WHY should Americans throw away between $35,000,000 and $40,000,000 every year in transforming coal into coke? Not only is there this direct loss of dollars and waste of the by-products representing such value, but the coke which results from the wasteful process is inferior to that which would be produced by the up-to-date processes that would save this great sum.



SEMET-SOLVAY BY-PRODUCT COKE OVENS, AT SYRACUSE, IN FULL OPERATION—NO SMOKE

But just what is coke? The residue of coal after the illuminating gas has been extracted, the fuel used by the housewife in summer time when she desires a quick, light fire in the kitchen range?

This is the coke with which probably most of us are familiar. As a matter of fact, it is an unimportant product as compared with the 40,000,000 tons of coke which is produced annually in the great coke fields of Pennsylvania, West Virginia, Virginia, Alabama, Illinois, Colorado, and other states. It is this metallurgical coke which has been such a prime factor in the country's industrial development. The bulk of the coke is produced solely for metal reduction—for use in the blast furnace, the foundry, and the smelter. In early times charcoal was used in metal reduction; this was superseded by anthracite but now practically all the pig iron produced in this country is made with coke alone and the remarkable increase in the output of the modern blast furnace during the last 25 years is intimately connected with the use of coke as fuel.

Any one traveling through the states named will be struck with the great lines of coke ovens pouring out their flames and smoke into the atmosphere and at night lighting up the sky with their red glare. Over 500,000,000 tons of this metallurgical coke has been produced in the United States since 1880, when the first coke figures were reported by the government, and the rapid increase in production has been an index to the development of the baser-metal industry. For such purposes as smelting, a fuel practically devoid of gases is required, and while anthracite and even charcoal were once used for this purpose, coke made from bituminous coal has come to be practically the sole fuel of metal reduction.

Yet the very picturesqueness of the Connellsville coke district with its many hundreds of blazing coke ovens denotes an almost unexampled waste of natural resources. Last year there was a direct waste amounting to a good $35,000,000, incident to the making of some 30,000,000 tons of the total production of about 40,000,000 tons of metallurgical coke. How is this? The answer is that three-fourths of the coke was made in beehive ovens so constructed that all the by-products of the coal used—the gases, ammonia, tar, etc., were burnt off into the atmosphere—wasted—whereas for the remaining coke made in by-product coke ovens, these by-products were saved to the value of $10,033,961. In the last 4 years, as estimated from the figures of the United States Geological Survey, had all the coke produced in the United States been made in by-product ovens, the value of these by-products saved would have amounted to at least $200,000,000. Had this saving process been applied to the entire production of coke since 1880 the gain to the country would have been fully $600,000,000.

Eventually the United States will conserve all these by-products, for coke making in the by-product type of oven is rapidly gaining; but we are still a long way from the attainment of this result. There seems to be every reason why the modern by-product oven should supplant the old and crude beehive type, but radical changes are ever slowly effected. As far back as 1881 Sir William Siemens made the following startling statement:

"I am bold enough to go so far as to say that raw coal should not be used as fuel for any purpose whatsoever, and that the first step toward the judicious and economic production of heat is the gas retort, or gas producer, in which coal is converted either entirely into gas, or into gas and coke, as in the case at our ordinary gas works."

Closely following this date and based upon the Siemens regenerator the by-product oven came rapidly into use in Europe, displacing the

*Washington, D. C.

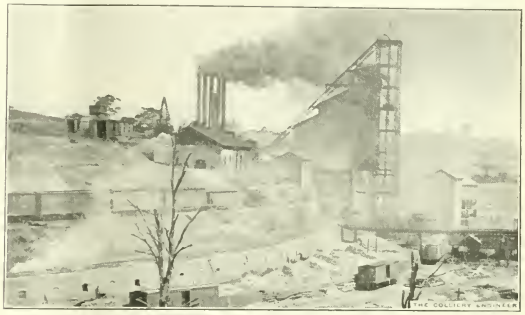
wasteful beehive type of coke producer and thus in some degree carrying out Sir William's theory. In the United States the transition has been much slower.

While at first glance it would appear that an institution such as the by-product coke oven, admittedly superior and more economical than the wasteful beehive oven, would quickly replace the latter, it is a sad fact that conservation of natural resources and business principles do not always travel hand in hand. A great investment is involved in the 100,000 beehive ovens in operation in the United States, and it seems moreover, that there is a persistent prejudice in some quarters against by-product ovens. Touching this subject of the preponderance of the beehive-coke output in America and the reason for failure to discard this poor type, E. W. Parker, Coal Statistician of the United States Geological Survey, has to say:

"The United States is much behind European countries in the abandonment of the wasteful beehive method of coke manufacture and still clings to this method, which may well be called antiquated. In Europe, particularly in Germany and Belgium, the beehive oven has passed out of existence. In those countries the retort oven, with or without by-product recovery, is now exclusively used. Where the by-products are not recovered the surplus heat from the combustion of gases is used in the generation of power, and it is estimated that about 15 horsepower can be obtained from each oven. Applying this average to the more than 90,000 beehive ovens in the United States it would appear that 1,350,000 horsepower is going to waste in the coke regions of the United States every day in the year. In the Connellsville and Lower Connellsville districts of Pennsylvania alone the energy available from the 38,000 ovens would exert 570,000 horsepower.

"In the early history of the industry the Connellsville district was found to produce an almost ideal furnace fuel in the beehive oven, and the example set in this district was followed in the development of other coke making districts. Iron masters became accustomed to the use of beehive coke and have shown a prejudice to retort-oven coke, principally because it does not possess the attractive silvery appearance of beehive coke. This prejudice, probably more than anything else, has been the most potential factor in retarding the development of the retort-oven industry in the United States." Mr. Parker states, however, that in addition to the fact that the yield of coke from coal treated in retort ovens exceeds that obtained in beehive ovens by about 15 per cent., the quality of the coke is actually improved. In spite of the old prejudice, however, in favor of beehive coke, the use of the by-product oven is increasing rapidly, the gain every year in by-product coke being considerably greater than that from beehive ovens, with a consequent increased saving of by-products and greater economy in the coal used. Thus, while the production of beehive coke in 1900 was 19,457,621 tons and by-product coke only 1,075,727 tons, in 1910 the production of beehive coke was 34,570,076 tons and the by-product coke was 7,138,734 tons, or over one-fifth. It will be noted from Table 1 that while the total production of coke in 1911 was considerably less than in previous years—due to the slump in the iron trade—the output of by-product coke nevertheless increased by nearly 10 per cent. The estimate for 1912 is even better.

The value of the by-products obtained from the manufacture of coke is a little more than one-third of the value of the coke itself. These by-products in 1911 consisted of 33,274,861 cubic feet of surplus gas over and above that used for making the coke, valued at $3,781,218; also,



Large Plant of Beehive Coke Ovens Wasting By-Products

69,410,559 gallons of tar valued at $1,638,314; also, 72,920,056 pounds of ammonium sulphate, or its equivalent, valued at $1,943,761; also,

Table 1. Coke Production

	By-Product Ovens	By-Product Production Short Tons	Beehive Production Short Tons
1895	72	18,521	13,315,193
1900	1,085	1,075,727	19,457,621
1905	3,103	3,462,348	28,768,781
1909	3,989	6,254,644	33,060,421
1910	4,078	7,138,734	34,570,076
1911	4,624	7,847,845	27,703,644

23,181,118 pounds of anhydrous ammonia liquor valued at $1,847,929, and 4,660,596 gallons of ammonia liquor valued at $548,824, besides secondary oils, etc. The value of these by-products recovered was equal to the value at the mines of the coal used—a truly remarkable showing.

Pennsylvania is the largest coke producer, and has also the greatest number of by-product ovens, 1,292, with 300 more now in process of construction. New York comes second with 556 ovens, Indiana third

with 540, Illinois fourth with 480, Massachusetts fifth with 400. Alabama has 340 but is building 280. In all there were 4,624 by-product ovens in 1911 and 700 additional in course of construction in 1912.

Only certain grades of coal are capable of producing good coke—the highest grades of bituminous coal. Such coals are therefore of great importance; in fact, they are the most valuable of all coals from the standpoint of national worth, even more important than anthracite, which while it is the most perfect fuel because of its smokeless quality and highest percentage of carbon, is in reality a domestic luxury. But the prosperity of the metal industry depends upon the supply of coking coal. In its classification of the public coal deposits the United States Geological Survey places high-grade coking bituminous coal at the top of the list and on a par with anthracite. The great bulk of this coal is found in the Appalachian coal fields, but there are good smaller deposits in a number of the Western States. Coking of coal is now carried on in a number of metal mining regions of the West where formerly coke was imported from Pennsylvania at great expense. It is interesting to note that investigations of the Geological Survey and of the Bureau of Mines have shown the feasibility of making good coke out of certain western coals which it was supposed were non-cokable. Coke was actually made in the government fuel testing plant from a Colorado coal obtained at a point where metal reduction works had been importing all their coal from Pennsylvania at a heavy cost of freight.

Coke is in fact a very fine fuel. As delivered from the coke ovens and used in smelting, it is in large chunks, but a considerable portion of the coke manufactured in the United States, besides that made in gas houses, is crushed in the same manner as anthracite, screened and sold for domestic consumption. Coke is a smokeless fuel and thus becomes a competitor of anthracite in those cities where emission of smoke from the burning of soft coal is prohibited by law.

The coal consumed in the manufacture of coke in the United States is drawn from the following bituminous regions or fields:

1. The Appalachian region, embracing the great coking coal fields of Pennsylvania, Virginia, West Virginia, Ohio, Eastern Kentucky, Tennessee, Alabama, and Georgia.

2. The Eastern Interior region which includes the coal fields of Illinois, Indiana, and Western Kentucky.

3. The Western Interior region, embracing the states of Iowa, Kansas, Missouri, Nebraska, Oklahoma, and Arkansas.

4. The Rocky Mountain regions, contained within the states of Colorado, New Mexico, Utah, Montana, and Wyoming.

The Pacific Coast regions, in which the only coking coals are found in the state of Washington.

The coal of the northern interior region lying wholly within the state of Michigan has not been used in the manufacture of coke. A considerable quantity of coke is made in states in which there are no coal fields, Massachusetts, Minnesota, New York, New Jersey, Wisconsin, Maryland, and Michigan.

It is thus seen that there is a wide geographical distribution of the industry. Alaska also has excellent coking coal and this is destined some day to be an important factor in the development of her own industries as well as those of the Pacific Coast. On this subject Dr. A. H. Brooks, geologist in charge of the Alaskan work of the Geological Survey says: "The high-grade coking coal of Alaska stands without a rival as to quality in any of the coals except of the eastern coal fields of the United States or those of inland China. We have iron deposits in Alaska and the Coast States and the time is approaching when there will grow up a great iron industry on the Pacific Coast. When that time comes Alaskan coke will be a prime factor in steel making."

A Practical Man's Way

A prominent Irish mine official in Pennsylvania, whose early education was very deficient, but who has made good through the use of great natural intelligence, good judgment, and quick wit, has under his jurisdiction a large mine opened by a shaft.

Some time ago the heavy oak collars originally put in at the foot of the shaft required replacement, and it was decided to use steel beams instead of timber.

The mining engineers were busy calculating the size of beams required, and incidentally asked Jim a few questions regarding the condition of the strata to be supported. Finally Jim asked "What are you doin'?" "Calculating the size of steel beams necessary to replace the oak collars," was the reply. Quick as a flash Jim asked "Didn't the oak collars hold the load for over twinty years?" "Yes," was the reply. "Thin, what the h— is the use of calculatin', why don't you spicify bames of the same strength?"

Centimeter-Gram-Second System

Electrical units are based on a system of measurement known as the Centimeter-Gram-Second or C. G. S. The centimeter is the unit of length, and is the one-hundredth part of a meter, which is the unit of length in the metric system and is equivalent to .3937 inch.

The gram is the unit of weight and is defined as the weight of a cubic centimeter of pure water at a temperature of 4° C. and is equivalent to 15.432 grains.

The second is the unit of time.

The dyne is the unit of force. This is the force which acting on 1 gram for 1 second produces an acceleration of 1 centimeter per second per second.

The erg is the electrical unit of work, or the work done by the force of 1 dyne acting on a body through the distance of one centimeter.

The unit of power is the erg per second.

Coal Mining Machines

With Special Reference to the Use of the Shortwall Machine—Early Coal Cutters and Their Development

*Wilbert A. Miller**

WITHIN the past few years a new term has been added to the vocabulary of mining, which, although commonly used, is not clearly understood by all miners. Almost daily mining men now hear the phrase "shortwall mining" and without explanation assume it to be a system of mining directly opposite to that of longwall mining, while in reality the term can be applied consistently only when mining coal by the shortwall mining machine in mines worked by the room-and-pillar system. The term "shortwall mining," however, indicates that the coal to be mined has a short wall or face compared with that of the longwall system, consequently, the phrase is not out of place when it is desired to specify that mining is being carried on by the room-and-pillar system, whether the undercutting is done by hand or machine.

It is proposed in this paper to describe in a brief way shortwall mining under the usual acceptation of the term; namely, with shortwall mining machines. This kind of coal cutting machine in general details is nearly similar to the longwall mining machines of the Goodman Mfg. Co., and both are driven by an electric motor.

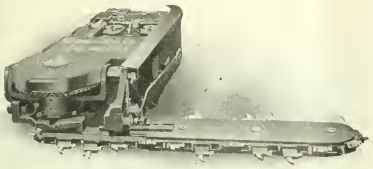


Fig. 1. Longwall Coal Cutter

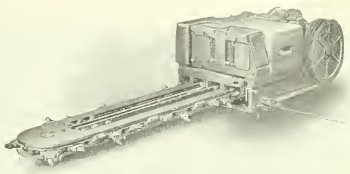


Fig. 2. Shortwall Coal Cutter

The shortwall machine is built so that its motor will load and unload it from its truck, move the truck from place to place, make the sumping or entering cut, and keep the machine up to its work as it moves automatically across the room. While the longwall machine is propelled and undercuts the coal by the power of its motor, and in some of the latest designed machines can also make the sumping cut by its own power, all other movements must be accomplished by power exterior to the machine itself. The difference between these two kinds of coal undercutting machines is shown in Figs. 1 and 2.

Fig. 1, is a longwall machine built on narrow lines, the usual width not exceeding 3 feet, to enable it to be operated along the face in longwall mining where the space between the coal and the gob is generally not much over 3 feet. The conditions governing this usually make it advisable to have the space between the coal and the gob narrow that the roof may sag uniformly and break or help break down the coal by its weight. When this may be done there is more lump coal produced than when mining is carried on by the room-and-pillar system. Fig. 6 represents a longwall mine with a longwall machine at work. In this case the space between the face of the coal and the gob is sufficiently wide to lay a track for the mine cars. In many mines this arrangement would not be feasible and the coal would be loaded at the entry after having been moved there in some way by the miners, by a buggy, a scraper line, or a conveyer.

The longwall machine shown is equipped with a reversible arm operated by the power of the motor, that enables it to make the sumping cut, and in this feature, as well as in that of power propulsion along the face, the machine is quite similar to the shortwall machine. Attention is directed to these two kinds of machines to show that the original conception of the machine employed in shortwall mining was the machine designed for longwall mining, but to which many features were added to

Fig. 3 Air-Driven Chain Breast Machine

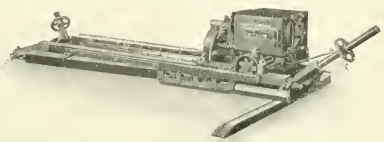


Fig. 4. Electric-Driven Chain Breast Machine

*District Manager, Goodman Mfg. Co., Cincinnati Ohio.

conform to the conditions of the narrow faces in the rooms and entries of room-and-pillar mining. In the room-and-pillar system coal is mined by shooting off the solid; by undercutting the coal with a pick, and breaking it down with a shot; or by undercutting with a machine and then blasting the coal. Shooting coal from the solid is an uneconomical and dangerous method of mining.

anthracite mines shooting off the solid in the past was supposed to be imperative, because the coal was too hard to undercut with a pick, or by a machine. Since there is no danger from dust explosions, the only objectionable features are the waste of power in breaking the coal, the loss from shattering and throwing the coal in the gob, and the bad gases in case of the blown-out shot.

from the solid. Undercutting with a pick being done by contract, the advance of a room or entry lagged when a miner became sick or failed to work from some other cause. Therefore the work did not always progress in a manner suitable for economical mining, and to avoid delays of this kind undercutting machines were introduced. The conditions which machines of this kind

Fig. 5. Shortwall Machine at Work

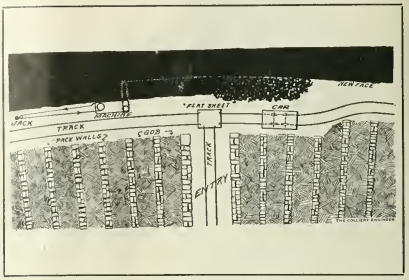


Fig. 6. Longwall Mining

It is uneconomical because it requires much more powder to break the coal from the solid than from where it is undercut and has two or three free faces; further, the coal is scattered about the room and broken into small pieces so that the miner is not paid for as much coal as he would be if he undercut his room face.

Again the charges of explosives being heavy there is great danger of shaking and making the roof unsafe, in which case it must be taken down or propped up, this adding to the expenses of both the miner and the operator.

Shooting off the solid is dangerous, in that windy or blown-out shots are likely to occur which would set fire to gas and dust and cause an explosion; and even if this did not occur the shots foul the air with harmful gas, and make it necessary also to drill and fire another hole. The cut, or first shot, when "shooting off the solid" is more dangerous than those following because of only one free face but no shots are absolutely reliable even when holes are pointed and fired by expert miners. In the

In some of the flat-bed anthracite mines in the Lackawanna Valley where the coal is not over 4 feet high, shortwall machines are being introduced. In bituminous coal mines shooting off the solid is a very different matter and leads to the dangers mentioned.

All coal-mine operators want their coal in lumps of reasonable size, and it was this desire coupled with the dangers from shooting off the solid that induced operators to adopt undercutting with picks. In England, in very gaseous mines, the coal is undercut with the pick as in Fig. 8 and wedged down. Undercutting is not a new proceeding, and in some instances shearing, or making perpendicular cuts in the coal, has been practiced rather than that of making under or horizontal cuts. Shearing, of course, gives two free faces for the powder to act on, but is virtually the same as shooting off the solid after the cut shot has been fired. In Oklahoma, the mine laws require the coal to be undercut. In other states, for instance in Illinois, the law permits the miners to shoot the coal

have to comply with are: speed in undercutting, because considerable money is involved in their installation, and if each machine could not perform the work of several miners there would be no economy in its use; the coal undercutter must be easily set up and handled so that it may be moved from one room to the next and placed at work quickly; also it must be strong and so arranged that the worn parts can be readily removed and new duplicate parts substituted.

The Harrison coal cutter, or punching machine, was introduced in the Dagus mines, Elk County, Pa., about 1880, and the Lechnor machine, a revolving bar cutter, was introduced about the same time at the New Catfish mine, Clarion County.

Thomas K. Adams, mine inspector, in his 1881-1882 report said: "As undercutting the coal is the most laborious part of the miner's work, it would be natural to suppose that he would look upon the introduction of the machine with some degree of satisfaction, but quite the reverse of this is true, and he seriously opposes

them. He seems jealous; as every machine can undercut so much coal he reasons that so many miners will be thrown out of employment as a result, and thereby create a surplus of laborers, lowering of wages, etc. Machinery does not lower wages, nor does it create a surplus of laborers. The miners, to be sure, will not be required to undercut the coal, but all of them will find employment which will afford them just as remunerative wages as before their introduction." Mr. Adams said further, "machines are operated by contract and the loading also. The undercutting is paid at the rate of $1 for every 6 tons of coal cut. The loaders are paid at the rate of 30 cents per ton for coal placed in mine cars. With 11.75 men one machine mined 59½ tons of coal in 8¾ hours at a cost of $26.03. It would have required 20 miners to produce the same tonnage, and at 68 cents per ton cost $40.40. Thus by the use of one Harrison machine there is a net profit of $14.37.

"The Lechnor machines are heavier than the Harrison and more time is lost in moving them from room to room. However, after these machines are set up they do not require to be guided by attendants while running, and do their cutting with more precision and uniformity than the Harrison machines. Compressed air is the motive power. The expense connected with running one machine and producing 40 tons of coal per day was as follows: Three machine operators, $6.75; three machine helpers, $4.50; six loaders, $9.00; one drill man, $2.25; 1 shot firer, $2. A total of $24.50. This does not include repairs on the machines or depreciation of the plant, nor up-keep of outside machinery. Miners on contract were paid 80 cents per ton." "Mining machines," Mr. Adams concluded, "were more profitable in low than in high coal."

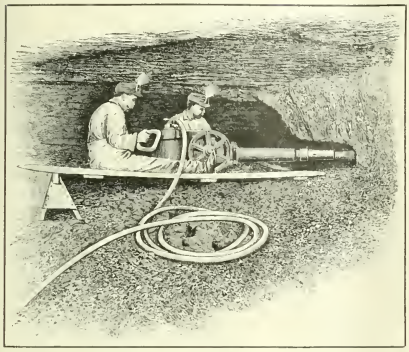


Fig. 7. Puncher Machine

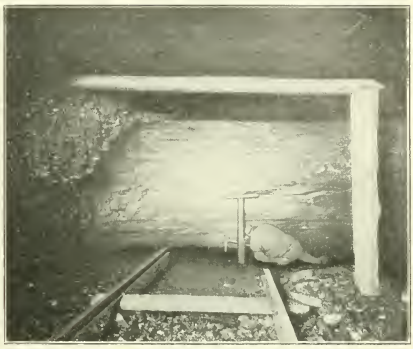


Fig. 8. Undercutting With Pick

From this it may be seen that the puncher machine shown in Fig. 7 was quite an advance over hand picks, both in quantity of coal produced per man, and in cost of production, and while the puncher never came into general use it is today particularly suitable to some mines where conditions are unfavorable to chain machines.

At first the puncher was operated by compressed air, generated at the surface, later the air was compressed by electric power near the machine in the mine. The objectionable feature connected with the puncher is the shaking and physical strain placed upon the runners, as well as the operator's inability to make all strokes of the machine do favorable work.

While the first chain machines were driven by compressed air, Fig. 3 shows a chain breast machine driven by a four-cylinder air engine, which, however, is interchangeable with an electric motor as in Fig. 4. The air machine is as successful in every way as an electric machine, and can also be equipped with self-propelling truck the same as the electric machine. It is used in a number of mines where no electrical equipment is provided. So soon as electric power was introduced, motors replaced air engines, and the development of the present coal cutters commenced in earnest.

The use of chain breast machines then became more general until at present they are used in almost every bituminous coal field in the United States, and their adoption is increasing yearly. Chain breast machines are particularly adapted to undercutting room coal, breakthroughs, and driving entries in room and pillar mines where the coal beds are thick, and the roof comparatively good. Chain breast machines require more clearance than other machines, and should have about 10 feet space between the face and the props, then under favorable conditions no machine so far designed will undercut more coal in a given time with a minimum expenditure of power and at any lower cost of investment or up-keep.

Shortwall mining is not limited to

a minimum length of coal face or other conditions. The width of the room and entries may differ. Various forms of panel systems of working may be employed. But where low beds of coal are to mined with roofs varying in strength, or where the chain breast machine has its successful use limited, the inventor stepped into the breach, and designed the shortwall mining machine, that is intended to maintain the output, or if possible increase the speed of undercutting coal. Shortwall mining machines are now constructed with all the improvements that time and experience have shown to be necessary for chain breast machines, and in addition are designed for their special kind of work. They make their own sumping cut and travel across the face when cutting almost as if they were human. They are provided with chain guards so that the machine runners or their helpers will not be injured by having their trousers caught by the bits. The operator stands at the rear of the machine where he has the levers that regulate the tension on the feed and tail-rope drums, the lever operating the feed-clutch, and the controller handle for starting and stopping the motor so that the entire operation of the machine is most convenient for the machine runner, who, standing close to the props, is in little danger of roof falls.

In low-bed coal the shortwall mining machine is most successful, as all conditions make it necessary to use a machine which can be handled entirely by its own power in a more or less restricted space. In Fig. 5 is shown the shortwall machine making the sumping cut, and has just swung into position on the right-hand side of the entry. The positions of the jacks for this cut are to be noted, and also the chain guard mentioned that protects the cutter chain. In this mine the entries are brushed for headroom, driven wide to leave room for haulage; and the stowing of waste and a narrow space between the right rib and the waste acting like a brattice furnishes good air to the face of the entry. When the sumping cut is completed the feed-rope in this case is secured to the jack at the left rib and the machine is ready to make a running undercut across the room.

Where the roof is good, the coal thick and the rooms are 25 feet or over in width, it is questionable whether anything is gained by using shortwall machines instead of chain breast machines, when the initial cost of investment and the power factor are considered, as the latter machines would undoubtedly produce more coal proportionally.

The machines are arranged for gassy mines so as to be flame-proof and conform to the standards suggested by the Bureau of Mines. The great advance made in the construction of machine coal cutters in the last few years has added greatly to safety and made them one of the most important features of present-day mining. In some instances rib drawing is carried on by shortwall mining machines. The Pittsburg coal operators granted the United Mine Workers of the Pittsburg district the following demand: "It is agreed that ribs and stumps will be cut with shortwall machines, with the understanding that the operator shall have the option of using any other kind of machine in all other places."

This agreement has driven some who did not own shortwall machines, or who were not supplied with enough of them, to revert to pick mining when drawing pillars. In some mines in other fields practically all the pillars are recovered by mining machines, only the small stumps being left for hand picks. In good mining as much as 90 per cent. of the coal is being recovered.

Ammonia bombs are being tried for the purpose of extinguishing forest fires. They are said to have worked well in the case of brush fires where the fire fighters find difficulty in getting near enough to the burning area to beat out the flames. Each bomb exploded will extinguish fire in a circle of 5 yards in diameter.

Miners' Field Day

For the Miners' Field Day that is to be held in Knoxville, Tenn., on September 20, in connection with the National Conservation Exposition, over thirty picked teams of mine men from the Southern coal fields have been entered and are now receiving their instruction at the hands of employes of the United States Bureau of Mines.

The field day will be held under the auspices of the Tennessee Mine Foremen's Association, assisted by the American Mine Safety Association and the American Red Cross Society.

Fifteen thousand miners from the Southern coal field—from Tennessee, Alabama, Virginia, West Virginia, and Kentucky—are expected to be in Knoxville for the day. The field day and the preparations for it that are being made are attracting attention in practically every mine of the South. Saturday, September 20, will be a holiday in the Southern field. The mines will close and the miners will be paid off on Friday, the day before, and thus all who so desire will be able to attend.

The following are some of the coal companies in the South whose employes have entered teams for Miners' Day:

Darby Coal Mining Co., Darbyville; Red Ash Coal Co., Caryville, Tenn.; Virginia-Lee Co., St. Charles, Va.; Tennessee Copper Co., Ducktown, Tenn.; Black Diamond Coal Co., Coal Creek, Tenn.; Luke and Drummond Coal Co., Middlesboro, Ky.; Roane Iron Co., Rockwood, Tenn.; Coal Creek Coal Co., Coal Creek, Tenn.; Tennessee Coal Co., Briceville, Tenn.; Consolidation Coal Co., Jenkins, Ky.; La Follette Coal, Iron, and Railway Co., La Follette, Tenn.; T. C. I. Co., Whitwell, Tenn.; Continental Coal Co., Pineville, Ky.; Knoxville Iron Co., Briceville, Tenn.; Campbell Coal Co., Westbourne, Tenn.; Wisconsin Steel Co., Benham, Ky.; Piedmont Coal and Coke Co., Oliver Springs, Tenn.; Stearns Coal Co., Stearns, Ky.; Minersville Coal Co., Pless, Tenn.

Ventilating Mines and Removing Gas

Methods of Handling Air-Currents and Precautions Suggested by Experience and Observation

By Dr. J. J. Rutledge

No department of coal mining is more important than mine ventilation, for on it depends the safety of the men in the mine and the preservation of the mine property. Moreover, every man in the mine is directly interested in its proper ventilation, since his life, as well as that of every other man in the mine, may be lost if the ventilation is seriously disarranged, and dangerous conditions such as accumulations of inflammable gas are allowed to exist. It is the duty, therefore, of every one in the mine to see to it that the ventilation is always kept up to the proper standard.

Probably in no branch of coal mining has there been a greater advance, during the last 20 years, than in mine ventilation, but the introduction of expensive ventilating machinery will be useless unless the management has the hearty cooperation of every one in the mine, especially the miner. Most of the advancement in recent years in mine ventilation has been in compliance with legislation meant to protect especially the lives and health of miners, and the miners, above all persons, should do their part in keeping the ventilating appliances in good condition. Carelessness on the part of any man in the mine, as in the leaving open of trap doors, etc., may render useless the best ventilating system and perhaps cause the loss of lives and damage to property.

Most miners and other mine workers are aware of the dangers pointed out in this paper, and they may be, therefore, disposed to treat lightly the warnings which follow, but it is only by the general recognition of the existence of these dangers and continued warnings against them, that those concerned will be brought to exercise constant care and accidents will be avoided. The following suggestions are made for the benefit of mine officials and employes in the hope that the observance of them may assist in the reduction of accidents.

Many miners' lives have been lost and the health of others ruined by insufficient or improper attention to the system of ventilation.

At mines where proper facilities and plans are adopted for the efficient ventilation of the working places and such other places as are frequented by the workmen, there are certain things which the miners, drivers, bosses, and others should do and also not do in order to maintain the ventilation of the mine to the highest standard for the safety of the men.

PRECAUTIONS TO BE TAKEN

A moving current of air within a coal mine is essential to the welfare of miners, from the standpoint of health, safety, and the efficiency of their labor.

Factors which contribute to the impairment of the air within a mine are those which change the relative proportions of the contents of normal air. Contamination of the air results from the exhaled air from men and animals, the burning of lamps having flames, the decomposition of mine timbers, the use of explosives, the absorption of oxygen by the coal, the liberation of gases from the coal or adjacent strata, and gases resulting from chemical reactions other than those mentioned.

The extent to which these factors are present in any mine governs the character and plan of the ventilating appliances to be adopted and maintained.

An efficient ventilating system is one which, with the least velocity, furnishes at the working faces air that, compared with normal air, has almost as high a percentage of oxygen (over 19 per cent.) and a low percentage of impurities such as carbon dioxide and methane, and no carbon monoxide. In order to be efficient, the ventilating current must supply sufficient fresh air to all the men and stock in the mine, and dilute, render harmless, and quickly remove all dangerous gases generated.

As a means of guaranteeing to the miners a good quality of air at their working places, most of the states and countries have, by legislative enactments, required that there shall be circulated a minimum quantity of air within a specified time for each person employed within the mine, and in some cases, additional quantity for each animal employed.

Plan and Control.—Before the mine is opened, a working ventilating plan should be prepared, and this should be adhered to, if possible, throughout the life of the mine. The fan should be located outside the mine and in such a place as to be out of the direct line of any explosive force which may come out of the mine openings. The quantities of air in ventilating currents should be measured regularly and the quantity passing through the main return or main intake should be noted at least once every week. If practicable, the manways should not be on the return airway since the return air may become filled with gases and hence become dangerous and probably ignited by an open light of some one traveling in the return.

The ventilating machinery and appliances should be so made that the air-current can be held under absolute control, so if it is advisable for the mine foreman or superintendent to vary the quantity of air going into the mine or any separate portion or district thereof, it can be quickly done. Regulators, doors, and other appliances should be so made that changes in the ventilating system can be quickly made if necessary.

Whether the ventilating fan should be operated by steam or electricity and the fan be forcing or exhausting depends on conditions, and is a matter of debate; but no matter what system of operating the fan is adopted, there should be some reserve method, so that the fan can be

run if the method by which it is being operated fails to work.

Fan Run Continuously.—The best plan is to have the ventilating fan in operation continuously, whether the men are in the mine or not. It is a well-known fact that mine timbers, wooden rails, cars, and other wooden objects soon rot if the ventilating current is not maintained. Moreover, the roof is affected disastrously when the supply of fresh air is intermittent. When the fan is not running continuously, dangerous accumulations of gas are apt to occur and these cause trouble when the fan is started again and work is resumed. Every fan at a mine should be equipped with recording pressure gauges which show the condition of the fan at all times, whether or not it has been in operation during the preceding 24 hours, and the amount of water gauge.

Large Shafts and Haulageways. Hoisting shafts should be made of such size that there will be no interruption to the air while the cages are in motion. The day of the cage ventilator is past and our modern built fans having demonstrated their ability to successfully ventilate any kind of a mine, it is no longer necessary to give the cages the air pump action which the old cage ventilating system required. There should be openings between the hoisting compartments to prevent the cages, while in motion, acting as air pumps and interfering with the ventilating current.

If the slope in dipping seams is not large enough, the motion of the trip on the slope may act as an air pump and disarrange the ventilating currents in the mine, or the stoppage of the trip at any part of the slope may be sufficient to disarrange or entirely choke the ventilating current. The airways should be made large enough so that a fall will not easily close them. Another point which should be noted, is the size of the mine cars; in their haste to obtain a large output, many mine foremen and superintendents install mine cars of such size that they almost completely fill the airways, and either shut off or seriously interfere with the air-current.

Owing to the disarrangement of the air that often results from the passage of haulage trips along main airways, the main airways should not be haulageways, if practicable, but the aircourses should be timbered.

Ventilating System — Automatic. As far as possible a ventilating system should be made automatic, that is, it should not have to depend for its successful operation on the faithfulness to duty of any employe within the mine. If overcasts are used, the air-current split, and the number of doors reduced to a minimum and these made self-closing, the ventilating current should be nearly automatic in its operation and each entry or pair of entries or each working district should have its own separate air-current.

Large Airways.—Airways should be of as large cross-section as practicable, and accumulations of dirt or slate should not be permitted in them. Falls should be removed when discovered, and, to facilitate the cleaning up of main airways, track should be maintained in them, so that cars can be taken in and falls loaded up and removed as quickly as possible. This is to be preferred to piling the material along the sides of the airways. Falls or obstructions in the air-courses obstruct the passage of air and reduce the quantity passing in a given time. Large airways, and slow moving but ample currents, should be maintained, rather than narrow airways and air-currents moving with such high velocities as to stir up coal dust and carry it along. If possible, airways should be so constructed and maintained that any gas liberated is quickly diluted with air sufficient to render it harmless and immediately carried out by the ventilating current.

By reason of blown-out shots or explosions of gas or coal dust, it is possible to obtain in the mine, conditions similar to those which exist in a water pipe when we have what is called a "water hammer." With the air-currents at high velocities, any disturbance occurring at one part of the mine, especially at the face of an entry or heading, is quickly transmitted to the other portions of the mine by reason of the high velocity and the high tension, so to speak, of the air. The writer has experienced this effect when present in a mine at the time when blown-out shots have occurred. He has also experienced the effect when operating mines which were ventilated by a ventilating fan placed over the mouth of the main hoisting shaft and hence working against the cage at times. If there is any doubt of the truth of these conclusions, the statement can be proved true by visiting a mine producing considerable output where the shaft is tightly timbered and there is a closed partition between the hoisting compartments and the cages are operated rapidly. In such instances the cages act as an air pump and by noticing the flame of an open lamp in almost any portion of the mine, the effect of the cage on the ventilating currents will be seen. This condition may also occur in a slope or drift of small cross-section in which trips of cars are run at high velocities. There is another reason for preferring the slower moving air-currents, in that the fast moving currents carry dust and this dust is available for any explosion which may occur, and furnishes material for propagating the explosion.

In mines working coal seams lying under strong roof and where it is possible to have large airways and entries, it is seldom that explosions occur, for ventilating currents are ample and generally move slowly.

Stoppings.—Stoppings should be made of such material and in such manner that there will be no leakage of air through them. Recently some investigations have been made as to the amount of leakage through stoppings, and the results obtained have been quite surprising. The amount of air lost through stoppings as ordinarily constructed is very considerable. The efficiency of stoppings of various materials is a subject worthy of investigation of all large mining companies.

Safety Valves—Doors.—On all side or stub entries the stoppings should

be made strong enough to carry the air-current and yet light enough to be easily blown out by any explosion. On the main entries, haulageways, and slopes, substantially built stoppings should be constructed since they must bear the force of the ventilating current for a long time. It is not necessary to construct elaborate stoppings on stub entries, in fact, it is safer to use lighter stoppings, since any disturbance originating in such entries will be apt to be localized through the failure of the light stoppings. For the same reason, there should be explosion doors on all overcasts, or undercasts, and on all ventilating fans.

When it is necessary to use doors in mines, these should, if possible, be made self-closing, by the use of weights or other means. It is generally necessary to have an attendant or trapper at most doors on main haulageways, and these trappers often neglect their duties, and trouble results; but if the doors are made automatic closing, there should be no failure to close when released.

Study the Ventilating System.—The mine foreman and fire boss should have a copy of the mine map in their possession at all times. It is a good plan to have it in blueprints that can be carried in their pockets. On this map they should have the course of each ventilating current definitely traced. By having this map in their possession, they will be able to proceed intelligently to repair the damage when any accident occurs which disarranges the ventilation. There should also be a copy of the mine map with the ventilating system traced thereon, hung in some prominent place below ground where the other employes will not fail to see it, to study it and understand the course of the air, so that in the event of a disaster they will have some idea as to the proper methods to follow in order to save lives and property.

Dipping coal seams should usually be ventilated by the ascensional system of ventilation; that is, the intake or fresh air should be conducted to the lowest part of the workings as soon as possible after it enters the mine, and then be made to circulate through the working places, starting with the lowest and gradually working up the dip toward the mouth of the mine. By this method the return air will be always rising toward the mouth of the mine and will at the same time be leaving the men so that the possibility of reaching a dangerous mixture will be minimized.

Measurement of Air.—The quantity of air coming into the mine should be measured at the foot of the downcast, or at the main intake, and also at the foot of the upcast, or in the main return, at least once each week, and the quantity recorded in the mine report book. The quantity of air in the last working place of each split should be measured to be sure that a sufficient quantity of the air reaches the men. At least 100 cubic feet of air per minute should be allowed for each man in the mine and 500 feet per minute for each animal. In the anthracite district of Pennsylvania 200 cubic feet per minute is required. If the mine generates inflammable gas, there should be allowed at least 150 cubic feet of air per minute for each person. There should be a separate split of air for every 50 to 100 men, depending on the laws in force in the state where the mine is located. If the ventilation is defective in any portion of the mine or in the entire mine, the foreman should not hesitate to withdraw the men from the areas affected. It is only by such vigorous measures as this that serious mine disasters are sometimes avoided.

Ventilating Old Workings.—In mining districts not subject to spontaneous fires, it is generally best that old workings be ventilated by an air-current, generally the return (as there may be gas) which should be allowed to sweep freely through them. If the old workings are roughly stopped off, there is always apt to be leakage and the gas foul the air and sometimes cause an explosion. Then there is always the possibility of inflammable gas gathering in the old workings in dangerous quantities, when they are shut off, and the miners may accidentally hole into them and cause an explosion, or this gas may be driven out by falls into live workings with disastrous results. Generally speaking, it is advisable to ventilate the old and abandoned workings. When it is not done, the only proper alternative is to surround them with heavy permanent stoppings of masonry, brick, concrete, or other fireproof construction.

Continuous Currents vs. Separate System—Splitting.—There has been much difference of opinion among mine foremen and superintendents as to which is the better system of ventilation, a continuous current or a separate split of air for each entry or for a certain number of employes, but, in general, it may be stated with confidence that the separate system is used in the best regulated mines. The mining laws of most coal producing states virtually approve and recommend the separate system of ventilation, in that most of them stipulate that only a certain number of men shall be allowed to work on any one split of air. A continuous current may be allowed in a small mine, where few men are employed, but should not be permitted in a large mine in which a number of miners are at work.

The principal reason for splitting air-currents is to provide each entry or pair of entries or district with fresh air, so that the men will be enabled to work to advantage. By this method, any gas occurring in the various entries or districts will be diluted with such a quantity of fresh air as to render it harmless and will be quickly removed and carried outside the mine. If there were no separate splits, gas in one entry or district might be carried by the air-current into other parts of the mine and there meet with other bodies of gas and finally a dangerous accumulation of gas would be the result. There is still another reason for splitting the air-currents and this is to reduce the frictional resistance of the air-current by reducing the velocity of the current.

In order that each entry or each section of the mine may have fresh air, the air-current should be split,

that is, pass the fresh or intake air into the working places in a certain entry or district and then immediately conduct the return air from that entry or district, usually by means of overcasts, into the main return currents and then out of the mine. By this means each section has its own air and the men working in it are not compelled to breathe the air that has been breathed by men in another section or entry. The gases are diluted and removed promptly by this means and carried out of the mine before they have been permitted to mix in dangerous quantities. However, the air should not be split too much; there is a limit beyond which splitting should not go, for if the air-current is split too often it loses its velocity, and there is soon not enough velocity to quickly move the gas in the split or not enough air to dilute the gas sufficiently to render it harmless. One must have a rather quick moving air-current in order to move gas. If each pair of entries has its own air, there is a possibility of the disturbances that so often occur in mines, such as fires, windy shots and blown-out shots, gas and dust explosions, being confined to the entry or section in which such disturbances originate, and not extending to or affecting the remainder of the mine, provided the doors and overcasts conducting the air in the remainder of the mine are not destroyed by an explosion. If these are blown out of course this would not be true.

In some mines the air is not split, but is kept in a continuous current which is made to pass in turn around the entire mine. If possible, the use of continuous currents in mines employing over 50 men should be avoided, as not only are the men compelled to breathe impure air by this system, but any fire occurring on the intake would send its smoke all over the mine.

In the separate system of ventilation each entry, or pair of entries, or each district should be so laid out that the area in which they are contained is separate and distinct from the remainder of the mine, and can be ventilated by a separate current of air. There should be no rooms or cross-cuts driven to connect this separately ventilated area with other portions of the mine workings in order to afford short cuts for haulage or to give the fire bosses and other employes easy access to other portions of the mine. If any certain area or district in a mine is separately ventilated it should be kept separated from the remainder of the mine by a solid body of coal. If this is not done, it is nearly useless to employ the separate air-current system of ventilation since the communication with other portions of the mine will allow leakage of air and thus destroy the value of the separate ventilating system.

Where a continuous current is used a single door left open may disarrange the entire ventilating current in a mine. Therefore, doors should be carefully watched when controlling a single continuous current.

The examination of the mine to detect the presence of gas should be made by a competent man carrying only an approved safety lamp, within 3 hours of the time when the men enter the mine. Every working place should be visited and some mark left to indicate that the place has been examined. The condition of each working place should be noted in a book kept for the purpose which is accessible to every underground employe. An open light should not be taken by the fire boss on his rounds, and, if possible, in order to avoid suspicion, the fire boss should wear a cap, or a hat, on which it is impossible to hang the ordinary open miners' lamp.

In all mines there should be a brattice man or men whose duty it is to look carefully into the condition of the ventilating current and to see that all stoppings are promptly and properly made and canvas curtains hung as soon as required, and that they are always kept in proper condition.

Who May Enter Standing Gas. The mine foreman must never, under any circumstances, permit men to go into portions of the mine which are filled with standing gas, or where there is reason to believe that there is any quantity of gas present. The foreman, or the fire boss, should carefully mark off such districts, using the danger sign specified by state law or by local custom; sometimes this is a wooden rail placed across the entrance to the working place, sometimes a wire tied across the roadway, and often simply chalk marks of a certain kind. The foreman should not, on any account, allow any one except himself or the fire boss, to enter such marked-off places, and he should never enter such places unless he has an approved lamp in good order with him. Before allowing any one to enter the place fenced off, he should so conduct the ventilating current that the gas will be removed by it; he should not try to brush the gas out by fanning with his coat, or a cloth, or by means of a small jet of compressed air from the air line, or by a hose attached to same; he should not clear the place of standing gas when there are any lamps, other than electric, on the return or in the vicinity. He may be burned, perhaps fatally, and others also. He must never light gas in a place in order that the gas will be burned and consumed so that the miner will be able to work safely. All gas should be removed only by the use of the ventilating current. He should pay particular attention to places going to the "rise" or up the dip in gaseous mines, especially if they are new places, and hence without cross-cuts to carry the air-current up to the working faces. Under such conditions the gas will often collect in the room, especially at the face, and will accumulate there in dangerous quantity, and be difficult to remove. Any one going into the room, with a naked light or a defective safety lamp will light the gas, and the result will be that they will be burned and probably a general explosion will result. The fire boss can remove this gas, in most cases, by hanging canvas curtains across the entry and forcing all the air passing along the cross-entry up into the room, carrying a line brattice up the center of the room in order to carry the air to the face of

the room, and drive the gas out. Generally, it requires some time to do this, but it must often be done if the gas is to be driven out and the men permitted to work in safety. No open lights should be permitted in the entry or district in which the gas occurs, while the gas is being brushed out, and no lights, either open or closed (safety lamps) should be on the return side of the curtain, or line brattice, at any time, since the gas at those points will be mixed with air in perhaps the proper proportion to cause an explosion. The foreman, or fire boss, should not permit work in an entry when old rooms on the same entry contain standing gas, even if they are fenced off, for the gas is apt to be driven out on to open lights at any time. Such places should be cleared of standing gas by means of the ventilating current before the men are allowed to enter the area.

Outside Air-Courses.—The writer has often noticed an accumulation of ice on downcast shafts during very cold weather. When a forcing fan is used and the air, or escape, shaft is used as a downcast, this accumulation of ice is apt to cause trouble, in that occasionally, during severe weather, the shaft is closed entirely by ice. At other times, when the main hoisting shaft is used as a downcast, the formation of ice in very cold weather, on the sides of the shaft, may interfere with the hoisting. In this case some of the Illinois managers have solved the problem by the installation of what is known as an "outside air-course." A frame shed about 8 ft.×10 ft. in cross-section and 60 feet long has been built over the mouth of the air-shaft. This shed has been lined with 3-inch pipe and the exhaust from the fan engine carried through these pipes. The cold air from the outside passing through this shed is heated up almost to the temperature of the mine and then conducted into the mine and in this way the prevention of ice is assured. The writer has observed this plan in operation in very cold weather and it was rarely necessary to use any live steam in the coils, the exhaust from the fan generally being sufficient. The reverse of this practice, namely, the cooling of the intake air in hot weather, should result in a reduction of falls due to the slacking of the roof in summer season. A trial of this method should yield valuable results.

Roof Coal at Cross-Cuts.—The writer recently examined a mine after a disastrous explosion had occurred in it and noticed that one of the contributary causes of the explosion was the condition in which the room and entry cross-cuts were left. The coal averaged about 7 feet in thickness, and since the operating conditions were rather difficult, on account of the high dip, and dirt in the coal seams, the roof coal was left up in the cross-cuts between the entries and between the rooms, but the roof coal was taken down in the faces of the rooms and in the faces of the entries. This condition permitted an accumulation of gas at the faces of the rooms and the faces of the entries and it was impossible for the air-current to move the gas out of the working places on account of the cross-cuts being made only in the lower part of the coal seam; hence it accumulated there in dangerous quantities and was finally ignited by a miner who attempted to brush it out on to the main entry with a canvas sheet and forced it back on to an open lamp. The cross-cuts in rooms and entries should be made to extend through the entire thickness of the coal seam.

Double Necks—Two Rooms.—About a year ago, the writer observed in a mine in the Alabama coal field, a very good practice which he desires to commend. The coal seam in the mine in question was about 4 feet in thickness and dipped at an angle with the horizontal of about 8 to 10 degrees and the rooms were turned up the dip and driven to a width of about 40 feet. There were two necks to each room with the pillar stump between them, and the gob resulting from the mining of the dirt seams which occurred in the coal, was used to build a solid wall along each roadway. The entire space between the two roadways and between the roof and floor was tightly filled with the gob and this tightly packed gob extended from the pillar at the mouth of the room to within about 5 feet of the face. A canvas sheet was hung across the entry between the two room necks and the air-current was forced up to the face of the room and carried the gas away from the face as fast as it was generated. By this method the dirt was kept in the mine, where it belonged, and was not hauled out to the surface at considerable expense; moreover, it was made to aid the ventilation. This system could be used to great advantage in other coal seams which present like conditions. It has the advantage of being automatic, and with proper attention from the mine foreman and the fire boss there will be no accumulation of gas in the rooms.

Spare Canvas at Mouth of Entries or Level.—The writer has recently observed in an Oklahoma mine a practice which he also desires to commend. The coal seam was opened up by a slope and the dip of the seam varied from 10 to 13 degrees. Levels were turned off the slopes at certain distances and rooms were turned up the dip off the cross-entries or levels. At the mouth of each level there was a large roll of canvas, placed there for emergency purposes. This was always available for the fire boss, or brattice men, and was especially serviceable at the time an explosion occurred from a blown-out shot, which explosion destroyed all the stoppings and made necessary the hanging of a number of curtains before the ventilation could be restored. The canvas did not have to be brought into the mine but was at the mouth of each cross-entry ready for use at the time of the explosion. In this way much time was saved and the ventilating current was soon established and the mine easily cleared and made ready for work. By having canvas ready for instant use at the place where it is required, the ventilation will be quite apt to be well maintained at all times.

Preventing Short-Circuiting of Air By Open Doors.—In the Pittsburg

district of Pennsylvania, a plan has recently been introduced which prevents the short-circuiting of air through the accidental leaving open of the doors at the mouths of cross-entries. Three doors are placed at the mouth of cross-entries and these are so arranged that when one is opened, the two others are closed and thus it is impossible to short-circuit the air.

Sampling and Analysis of Mine Air. When inflammable gas occurs in a mine in any quantity, the best possible method of insuring the safety of that mine against explosion is the systematic collection and analysis of samples of the mine air. In this way the amount of gas occurring in any particular area or district can soon be ascertained and the quantity of air necessary to dilute this gas, and quickly remove it from the mine, can be ascertained. The mine foreman, or superintendent, can change the amount of air in the splits when necessary and thus make safe that portion of the mine I am glad to know that this system is being used in Alabama and also in several other states.

Gob Gas vs. Gas in Live Workings. One often hears mining men say: "I am not afraid of gas in the live workings, but I am afraid of gob gas." By this statement they mean that the gas which gathers in the working rooms, headings, entries, and aircourses is soon discovered and generally quickly removed, since it will interfere with the safe operation of the mine, but the gas which collects in old workings, such as abandoned rooms, or pillared areas, is not readily discovered and hence often accumulates in dangerous quantities and may be ignited by careless miners. Moreover, since it is generally difficult to remove gas in such places those in authority are apt to neglect it, after fencing off the areas where the gas is found.

When an accumulation of gas is found in any portion of the mine, all men should be removed from that district and no one allowed to enter it, except the fire boss and his helpers, until the gas has been removed.

Pillar Workings.—In pillar workings, conditions are apt to occur which are not found in other portions of the mine, by reason of the roof falling after the coal in the pillars has been removed, and causing cavities in the roof in which gas accumulates, often in considerable quantities. This gas is not easily removed by the ventilating current and often reaches dangerous proportions. For this reason, many mines require the use of closed lights entirely in the pillar workings; and some of the best regulated mines have a man stationed near the pillar workings, whose duties are to take away the open light from any one passing beyond his station into the pillar workings, and to give in return a closed safety lamp. When there is a considerable quantity of gas in these pillar workings and the area being worked is very large, it is sometimes impossible to remove the accumulations of gas by means of the ordinary ventilating current, and this gas then becomes a decided menace to the safety of the mine and the men in it. In such instances the remedy is the sinking of a bore hole from the surface down to the area containing the gas and allowing the gas to escape through the bore hole to the atmosphere.

Removal of Gas.—Gas should only be removed from the mines by means of the ventilating current; this is the only safe method. One often notices the miner, or fire boss, lighting the gas in order to burn it out and make his place such that he can work in it with a naked light on his cap. This is a dangerous practice, since no one can tell in advance just how much gas is there and just what the mixture is, and there is always apt to be an explosion resulting from this ignition of the gas.

Another practice is the removal of the gas by means of compressed air. The writer knows of at least two mine explosions which, in his opinion, were caused by the use of this method of removing gas from mine workings. In each instance the compressed air pipe was used to blow gas from the cavity in the roof at the face of an entry and this gas was blown back on the flame of an open lamp behind the miner who was using the air pipe to blow the gas out of the place.

Gob Reservoirs of Gas.—The gobbed portions of entries and airways often act as storage reservoirs of gas, and this is due to the fact that the gob is not tightly packed. Since the fire boss in his rounds rarely examines the gobbed areas, an accumulation of gas may occur and often does in the gobs, and explosions result from the ignition of this gas. In testing for gas in these gobbed areas it is often necessary to use a pipe, by means of which the gas is sucked out from the area to a safety lamp, and a quantity of the gas tested in the safety lamp.

Fencing Off Gas.—When the air is found to be filled with gas, especially standing gas, it should be fenced off and no one permitted to enter the district until the gas has been removed. There should be some sign showing that the area has been fenced off and to pass such a sign or dead line should be made a felony.

Blight Killed Chestnut

Officials of the United States Department of Agriculture recommend to prevent the spread of the chestnut blight that shipments of chestnut lumber should include only material from which the bark has been removed, and from which the disease spots have been cut out.

Strength tests made by the Forest Service indicate that sound wood from chestnut killed by the bark disease is as strong as that from green lumber. The bark disease kills a tree by girdling the trunk, and does not cause unsound or decayed wood.

Until 2 years after the death of a tree the wood generally remains sound, though at the end of that time insects have commenced work in the sap wood. Three years after the death, the sap wood is honeycombed with insect burrows, and in 4 years it is decayed, and it begins to dry and peel off in the fifth year.

Relation of Subsidence to Packing

The Effects and Direction of Operation of the Forces Liberated When the Coal Is Removed in Working

*By George Knox**

THE present high death rate from falls of ground accompanying mining in Great Britain is evident proof of the failure of legislative action to arrest this evil.

George H. Harrison, in his recent presidential address, had to confess that, even with systematic timbering, the number of accidents from this cause, "for the period which has elapsed since the special rules were established," is "practically identical with those in force at the time when these rules came into operation". He attributed this to the methods of timbering in vogue today, which were based on methods already is use at many of the collieries before the Special Rules were established.

In the period 1893–1910 falls of ground accounted for 48 per cent. of the total accidents underground, whereas, in the year 1910, 49.2 per cent. of the fatal and 35 per cent. of the non-fatal accidents were due to this cause.

Dr. W. N. Atkinson, in his annual report for 1910, remarks that "until a higher standard of security is adopted, both by officials and workmen, this large loss of life will continue."

What is the "higher standard of security" usually implied as the remedy to minimize this evil? Generally speaking, it may be summed up in the oft-repeated phrase, "greater care on the part of the officials and workmen in the systematic propping of roof and sides." Some improvement might naturally be expected if a proper system of timbering were adopted in all mines, to suit the conditions of every particular seam; but if the cause (subsidence) producing the need for roof supports generally be not dealt with, there is not much likelihood of achieving any great saving of life and mineral.

In extracting coal seams, there are two distinct kinds of supports to be considered; namely, (*a*) the amount of permanent support left in the worked area for regulating the subsidence of the overlying strata; and (*b*) the temporary support between the permanent support and the working face for preventing any sudden movement of the descending mass

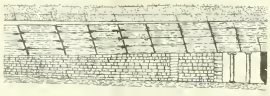


Fig. 1. Roof Fractures Due to Irregular and Uneven Subsidence

from suddenly breaking off pieces of the under-roof strata.

Attention has centered largely on the need for some system for the latter type of support and probably an exaggerated importance was attached to systematic timbering of faces by the results recorded at Courrieres, where the death rate from falls of ground was reduced by systematic timbering from .76 per thousand during the decennial period 1870–1879 to .15 per thousand in the decennial period 1890–1899.

After a personal investigation of the methods adopted at the Courrieres and other Continental collieries where satisfactory results have been obtained, the writer is of the opinion that the careful attention paid to the packing of the goaf, which accompanied the systematic timbering, had quite as much effect in reducing the accident rate as could be directly attributed to timbering at the face.

That "no one was ever killed with a bad roof" is a proverb among miners; and it is to a large extent justified by experience. The comparative safety in working seams with a bad roof is also probably due quite as much to the greater amount of care of propping at the face.

As a rule, wherever it is found that officials and workmen are prepared to apply a well-thought-out scheme of temporarily supporting the working faces, it will usually be found that they realize the necessity for systematically applying permanent supports in the form of packs; hence, the difficulty in determining directly how much of the improvement is due to temporary or to permanent supports, respectively.

Something more tangible might be accomplished in the reduction of the accident rate if a census of the accidents from falls of ground were tabulated in relation to (*a*) the thickness of the seam; (*b*) the method of working adopted; (*c*) the system of propping in use: (*d*) the nature of the overlying strata; (*e*) the number and position of the faults; and (*f*) the efficiency of the packing, in relation to subsidence and fracturing of the roof strata at the faces.

It is a well-established fact that in thick coal seams the loss of life and mineral, and the cost of working and the surface damage is more than in thin seams. In the thick coal of South Staffordshire the accident rate is about three times as great as the average for the United Kingdom; about 40 per cent. of the coal is lost, and the damage to the surface is very great.

In the thin seams of this country the average wastage—apart from pillars and barriers—would appear to be about 5 per cent. of the total coal, while in thick seams like the Dysart Main and Lochgelly Splint (Fife), the Barnsley Bed (Doncaster), the Wigan 9-foot seam, and the 18-foot seam of Neath (South Wales), the loss has been estimated at from 20 to 50 per cent. The average wastage in the United Kingdom due to unworked coal varies from 10 to 20 per cent., and if to this be added the losses through fires, floods, coal thrown into the goaf, and coal left in pillars and barriers, the average for the United Kingdom cannot be less than 20 per cent Taking the total available coal supply in Great Britain at 100,000,000,000 tons, this would mean a loss

*Abstracted from Transactions of the Manchester Geological and Mining Society.

of 20,000,000,000 tons, the bulk of which could never be recovered.

The small loss of mineral wealth and lower accident rate in thin seams (which usually are efficiently packed), compared with the great wastage of life and mineral in thick seams (which usually are imperfectly packed)—assuming that the same care is taken in timbering at the face—would appear to lead to the conclusion that the lack of permanent support is largely responsible in the latter case for the present deplorable conditions.

Another reason for the continuing high accident rate from falls of ground is the increased area worked from individual shafts—on account of the increased depth—necessitating long roadways being kept open through large areas of goaf, and for longer periods than was formerly necessary. The working of the deeper mines is also accompanied by an increase in pressure on the roof strata, and these new conditions render efficient packing an object of primary importance.

It has been shown by various writers within the past few years that it is now possible to determine approximately what will happen to the strata overlying a coal seam when the coal is being worked and the goaf only partly or fully supported.

When a layer of coal is being removed, two potential forces are liberated, one due to gravity acting downwards (at a pressure of about 1 pound per square inch per foot in depth) and the other acting horizontally (in a direction opposite to that of the workings). If the packing be inefficient, the downward weight acts suddenly and irregularly, breaking the roof strata by a series of "slip" faults, as shown in Fig. 1, and throwing a large amount of extra pressure on the edge of the solid coal at the face.

The two forces referred to are both acting toward the region of least resistance (the goaf), thus forming planes of strain projecting over the solid coal. The maximum subsidence of the surface is, therefore, always greater in area than the goaf below, and will vary according to the rate of advance of the working face, the nature of the overlying strata, the presence of faults, etc.; but the obliquity of the resultant of the two components forming these planes seems to be determined chiefly by the efficiency of the packing, Fig. 2.

The distance that surface subsidence is projected in advance of the working face (that is, the amount of horizontal draw) varies with the efficiency of packing adopted. In bord-and-pillar workings, where the roof is allowed to fall in as the props are withdrawn, the draw appears to be about a tenth to an eighth of the total depth; in longwall seams with good packing, a quarter to a third of the depth; and where hydraulic packing is used, to even greater distances.

Where the draw is short, the downward force is allowed to act freely, breaking the roof strata along the line of face, and with a strong roof pieces are liable to be broken off suddenly between the props or between the props and the face.

Where the draw is increased (by packing the goaf) the vertical force is partly arrested by the pressure of the horizontal force projected against the subsiding zone, which throws a greater proportion of the weight forward on to the solid coal, allowing gradual settling, with the roof unbroken.

The weight on the roof strata in the area mined acts in the form of a lever supported at both ends. As the lower strata are in a state of tension, they are thrust downwards, and break off in the form of an arch. Over the solid coal the horizontal force acts on the strata in the form of a cantilever, the lower strata being in compression and the upper strata in tension. In the former case the neutral line will be high, while in the latter it will be very low, owing to the difference in the ratio of strength of the strata to compression and tension.

As the coal at the face is being undercut, and the roof strata above leaves the "solid" and enters the mined zone, a change of strain—from

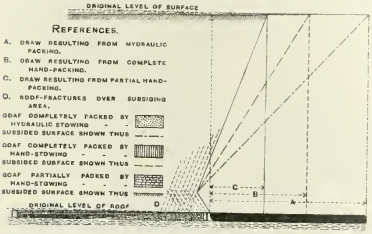

ORIGINAL LEVEL OF SURFACE
REFERENCES.
A. DRAW RESULTING FROM HYDRAULIC PACKING.
B. DRAW RESULTING FROM COMPLETE HAND-PACKING.
C. DRAW RESULTING FROM PARTIAL HAND-PACKING.
O. ROOF-FRACTURES OVER SUBSIDING AREA.
ODAF COMPLETELY PACKED BY HYDRAULIC STOWING - SUBSIDED SURFACE SHOWN THUS
ODAF COMPLETELY PACKED BY HAND-STOWING - - SUBSIDED SURFACE SHOWN THUS
GOAF PARTIALLY PACKED BY HAND-STOWING - - SUBSIDED SURFACE SHOWN THUS
ORIGINAL LEVEL OF ROOF
C
B
A
O

Fig. 2. Relation of Subsidence, Relative Draw and Efficiency of Packing

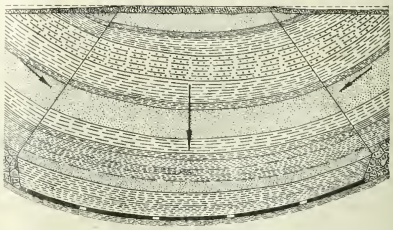


Fig. 4. Loss of Coal Caused by Subsidence Resulting From Bad Arrangement of Working

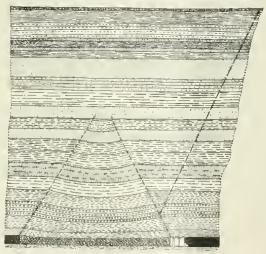


Fig. 3. Fractures in Strata When First Weight Takes Place

compression to tension—must take place in the rock particles. The nearer the line of strain approaches to the vertical, the more sudden and violent will the reactions become between these forces in the roof strata at the face. To minimize this, the plane of strain should be thrown as far back as possible, as shown in Fig. 2, thereby increasing the horizontal pressure and allowing the reactions to take place slowly and evenly. This would be particularly advantageous in the case of strong roofs, where otherwise the tendency would be to suddenly thrust off pieces of the roof strata.

In opening out the workings in a partly packed seam, the only evidence of strain, as the workings become beyond the shaft pillar, is that of "thrusting," Fig. 3, until a sufficiently large area has been mined to permit of the huge rock lever breaking through to the surface. When this great "first weight" takes place, the strata will cut through at the face, as shown in Fig. 2, up to the surface. As each undercut is made, new fractures parallel to the first will be produced, and the roof, instead of subsiding solidly and evenly on the packs, will probably come down in a series of jerks between the fractures. If the seam is thick and the face advances slowly, the cost of timber and the upkeep of the gate roads will be very great; and even where systematic timbering is in use, accidents are likely to occur frequently. In very thick seams, where the rate of advance at the face is slow and the packing is proportionately inefficient, as is usually the case, the cost for timber may be as much as 12 to 18 cents per ton of coal, without affording to the workmen a very high degree of safety.

In the St. Etienne coal field of central France these difficulties were largely overcome in the 21-foot seam by a system of complete hand packing at a cost of about 20 cents per ton. The packing material was quarried on the surface, and sent into the mine. The coal was extracted in three layers of about 7 feet thick from the bottom upwards, the goaf in each case being packed, so that the top of the pack became the floor for the succeeding layer.

In the roof strata immediately behind the working face the V-shaped area formed by the planes of strain, Fig. 2, becomes badly broken if allowed to stand too long on temporary supports; it is difficult to keep up, and often exceedingly dangerous to work under. Even when systematically timbered, if the roof is hard and brittle, it becomes almost impossible to prevent pieces from being suddenly thrust off if the roof is allowed to cut through by the inefficiency of the permanent support.

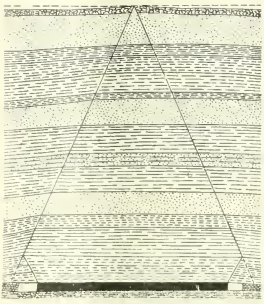


Fig. 5. Pyramid of Strata Resting Directly on Top of Coal

If subsidence could be reduced from the maximum of 30 to 70 per cent. of the height of the seam (which is frequently the case with inefficient packing) to a minimum of 5 to 10 per cent. (frequently obtained by hydraulic stowing), and the roof strata allowed to subside gradually and evenly on the packs without fractures, better results might be expected from the application of systematic timbering than those that obtained in present-day practice.

With complete packing, the reduction of subsidence would also tend to prevent the drainage of large volumes of gas (and in many cases water) from the overlying strata into the mine workings. As open spaces would not be left in the gob in which gases could collect another serious danger would be removed in fiery mines. Not only is it possible for these gas-collecting spaces to be accidentally fired, but if the roof were to suddenly break into the goaf, the gas might be forced into the air-current at the face at a velocity which would render the ordinary miner's lamp unsafe.

Where the goaf is completely packed, all the coal can, as a rule, be extracted, but even in cases where coal of a poor quality is left behind, it would be impossible for gob fires to take place where hydraulic stowing is used. Seams up to 50 feet thick, where gob fires frequently occurred, when only partial packing was in use, are now being worked and completely packed by hydraulic stowing without the slightest risk from gob fires. In fact, wherever this system of packing has been adopted, gob fires have been entirely got rid of.

Cases have been observed where large areas of coal have been lost through lack of attention to the cause of subsidence. Fig. 4 is an example where a series of pillars in a 9-foot seam, covering an area measuring about 1,200 yards in length by 400 yards in width, was rendered unworkable through the extraction of the pillars on the rise sides of the basin, and allowing the strata to break to the surface, this forming a high rock pyramid which rested directly on the coal seam. Fig. 5 is another example where a 6-foot seam was worked from two different shafts toward each other. When the faces approached within 200 yards, it was found impossible to keep the strata from cutting down along the faces and filling up the gate roads.

Recently, the Wearmouth Coal Co., Ltd. (Sunderland), were forced to stop working the Hutton seam on account of the heavy charges for surface damages resulting from subsidence, which in one case amounted to about $500,000.

The well-established fact that stowing material carried in by water and allowed to settle would completely fill the hollow spaces and become of such density that it would safely carry the overlying strata, in place of the mined minerals, in the

ratio of about 90 per cent., led to the application of hydraulic packing of goaves in mines. This system is practiced extensively in Continental, American, and some Colonial coal and metalliferous mines.

In most mines the problem of safety in coal getting is very largely the problem of regulating the subsidence of the strata, and the same may be said concerning the saving of our coal supplies. It is evident that the regulation of subsidence is largely determined by the efficiency of the packing used, and that the most complete system of packing known is the hydraulic system; it is justifiable, therefore, to assume that the application of this system—particularly in the thick seams of this country—would be equally as successful as the results achieved in other countries.

Production of Stone Dust in Collieries

Written for The Colliery Engineer

In Great Britain experiments have been carried on with some degree of success with regard to the prevention of explosions in mines by means of spreading stone dust in the underground roads. It appears to be definitely ascertained that given the right kind and quantity of dust, an efficient means for preventing the spreading of an explosion is obtained by interposing stone-dust zones in the entries, and thus preventing the coal dust rising in a sufficient quantity to feed an explosion. It is, however, important not only that the dust should be of a proper nature, but also that it should contain the right proportions of fine non-inflammable material to produce the best results. It has been found that stone containing any considerable quantity of silica is unsuitable for the purpose because the silica is an irritant and injures the health of the miners. The hard shale and fireclay which is usually found in considerable quantities in most collieries has proved to be almost an ideal material. According to experience the dust should be of a fineness giving approximately the following residues:

Residue on 10 mesh, 7.9 per cent.; residue on 30 mesh, 26.32 per cent.; residue on 60 mesh, 47.32 per cent.; residue on 90 mesh, 52.68 per cent.; residue on 100 mesh, 57.94 per cent.

Shale ground to this fineness gives the necessary fine material to mix in the most efficient manner with the coal dust in the underground entries.

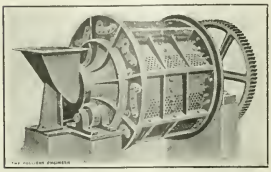


Fig. 1. Mill for Preparing Stone Dust

To obtain this fine material, special machines have been built on the lines of the ordinary ball mill. Such mills are complete with their own screening arrangements, and only deliver material of the required fineness. The mill shown in Fig. 1 has a feed opening designed so as to take pieces of stone up to approximately 6 or 8 inches in diameter. This avoids the necessity for a preliminary breaker. The power required for driving and the wear and tear on the plant are both low compared with the output, while the space occupied by the machine is also reasonable.

The machine consists of a revolving drum having perforated plates, the insides of which are protected by means of hard steel lining plates. Inside the drum is a permanent charge of forged steel balls. The drum is carried at the driving end in suitable bearings and is driven by means of gearing by belts, or direct by an electric motor. At the hopper, or feed end, there is a large feeding orifice surrounded by a steel tire, and carried upon adjustable antifriction rollers. The perforations in the mill's plates are of a suitable size to allow the fine ground materials to pass through while a series of intermediate screens fitted upon the periphery of the plates, allow a certain amount of the coarser material to go through to the finishing screens. The rejections are passed back through slots into the mill for further reduction. Surrounding the whole body of the mill are finishing screens of different sizes to give the necessary fineness of dust required. Rejections from the outer or finishing screens are passed back into the mill for further reduction in exactly the same way as in the intermediary screens, that is to say, by means of scoops through the slots in the mill. The whole body of the mill is surrounded by a dust-tight casing which is tapered to a suitable delivery orifice so that the material can either be bagged, or delivered into barrows or carts as may be required. Moreover, the orifice of the casing is sometimes provided with a door so that the material can be accumulated in the casing if so desired.

The material fed the mill falls upon perforated plates in the interior and the revolution of the mill causes both the balls and material to be carried round to a point about 60 degrees from the horizontal where the contents are thrown over and forward. The balls crush the material to a powder and the coarse pieces which escape through the holes in plates are dealt with as described above.

The mill being a complete grinding and sizing plant, accessory apparatus or machinery is not required. When new grinding balls are needed, they are introduced into the mill along with the material to be ground. The plant is therefore one which is easily installed and economically worked and is a valuable means of dealing with the problem of providing a sufficient supply of the necessary stone dust at all times.—*J. A. S.*

Correction

It was Mr. F. C. Greene, not Green, that designed the hoisting plant for the Maryland Mine, St. Michael, Pa., described in the August Colliery Engineer; and the C. O. Bartlett & Snow Co., of Cleveland, Ohio, constructed the plant.

Complete Mine Maps

The Methods of Making the Surveys and Recording Them According to the Standard of the Philadelphia & Reading Coal and Iron Co.

Written for The Colliery Engineer

In 1872, the late General Henry Pleasants, then chief engineer of the newly organized Philadelphia & Reading Coal and Iron Co., set a standard of completeness for mine maps that, with slight improvements, has been adhered to ever since by the engineering department of that company, and has been adopted by several of the other large coal-mining companies.

The geological conditions of the Schuylkill region, in which the operations of the P. & R. C. and I. Co. are located, are such that greater engineering problems are encountered in the matter of safe and economical coal mining than is the case in any other region, with the exception of that part of the anthracite field known as the Lehigh region.

General Pleasants recognized these conditions and his standard was set to meet them.

The same method of making complete mine maps will unquestionably be of great value in all fields, even in those in which the strata are regular and entirely free from distortion.

A general description of the methods of making the surveys and maps is as follows:

All surveys are based on the true meridian, and connecting surveys tie all the company's operations and adjoining operations of other companies together. All main surveys are checked by "tie surveys" where possible or by resurveys. Vertical angles as well as horizontal angles are taken, and tidal elevations are carried to every station and point sighted to. These tidal elevations are based on the elevations of established bench marks. In the absence of such bench marks, an assumed basis can be used.

On the surface, all prominent natural features such as streams, coal outcrops, rock in place, benches on hillsides, etc., are accurately located and their tidal elevations determined. All prominent improvements, railroads, team roads, buildings, etc., are also located and the elevations of the surface above tide are shown. In the case of rock in place, the ledge is not only located, but the kind of rock, the amount and direction of dip, and the direction of the strike is also recorded. In case of railroad or road cuts, the various strata of rock are located, and their dips recorded. In every survey made on the surface, besides tidal elevations of the stations being taken, sights are taken to every marked change in the topography in the neighborhood, and data are thus secured from which an accurate contour map can be constructed, if needed.

As stated before, the surveys are based on the true meridian, and to assure convenient permanent points at each colliery from which to start special surveys, either iron or stone posts with center holes are set in a safe, convenient place. These posts are of sufficient length to extend below the frost line. After these posts are located, sights are taken from each to from six to a dozen distant steeples, gables, flagstaffs, etc., and the angles recorded. In no case is a survey started from a single backsight. One principal backsight, and at least one check sight are taken to assure the transitman that his starting points have not been disturbed.

In carrying the survey into the mine, especially in the case of shafts, great care is exercised in the use of fine steel or copper wire plumb-lines, and the accuracy of the work done must be tested by a tie survey out the second opening, if it is possible, or, if it is a shaft, by plumb-lines let down from the surface.

In making the general, as well as the periodical surveys, the tidal elevations are carried to every station and a point sighted to in the mine, and the relative position of the bottom slate to the point is noted, so that if desired a contour plan of the bed of the seam can be constructed. The dip of the seam is noted at every station, and oftener if it changes for any marked extent. In both haulage roads and chambers, the distances to the ribs right and left of the line of sight are measured and recorded. Every passageway is accurately noted, and every condition that is abnormal, such as a thinning or thickening of the seam is noted and located.

Frequent cross-sections of the coal seam are made at definite points, and the various benches of the seams and their nature are noted. These cross-sections of the seams are kept filed in the notebooks, and are not shown on the map unless there is a fault, when its presence is shown by cross-hatching or some other conventional sign. In all cases the transitman who makes the survey plats the notes. This is necessary if completeness is to be assured. The comparatively voluminous side notes are usually abbreviated in the notebooks, and the man who made them can depict the information better than any one else, and the better the notes are depicted the more accurate and complete the map.

All the mine maps are made on best quality of mounted paper, carefully shrunk. Before any platting is done, 10-inch squares are carefully laid out over the entire surface of the paper, set so that the lines that cross the paper are on the true meridian, and the transverse lines are due east and west.

When separate maps are used to show the workings of different collieries, there are squares on each map that are common to both, and these serve to fit tracings together when it is desired to see the relative positions of the workings.

Before platting, the survey is traversed and the stations at each end of it, if not too far apart, or those at each end and several intermediate ones, are located on the paper according to the traverse, the intermediate stations being platted in by means of an arm protractor and a parallel

ruler. the latter being set on the meridian nearest the station from which any course is drawn. This ensures greatest accuracy and compensates for the stretching or shrinking of the paper. Naturally the system of ventilation is shown by arrows, and such other features as occasion demands are shown by established conventional signs. The advantage of mine maps constructed on the above lines must be apparent to mining engineers and mine managers with an engineering experience. In most cases every item of information necessary to safe and economical working, to further development of the mine, to surface protection, etc., is contained on the map, and is immediately available. If, as is the case in many instances, a cross-section showing relative positions of the various seams and rock strata, with the anticlinal and synclinal axes, or rolls, or faults is desired, the information for the construction of such cross-section is at hand, and it can be quickly made.

Report of English Explosions in Mines Committee

*By James Ashworth**

The Fourth Report of the English Explosions in Mines Committee, when carefully examined cannot fail to cause renewed interest in coal-dust explosion problems. Firstly, because the committee have scheduled coal-dust combustion under two heads; viz., (*a*) "inflammation" and (*b*) "explosion."

As to (*a*), "inflammation," is described as being "the burning of gases distilled from coal dust." It has been acknowledged that in the case of such combustion, carbon monoxide, which is first produced, is afterwards burned to carbon dioxide. Scientists have proved two distinct effects, that there cannot be an explosion or combustion of carbon monoxide without the addition of moisture to the air, and moreover that 5 per cent. of moisture must be present to produce the strongest explosive effects. This at once brings us in collision with those theorists who hold that dampening mine air gives perfect security against the extension of a coal-dust flame. The report under review does not state what was the hygrometrical state of the atmosphere at the time the experiments were made, but as the testing station is near the sea the air would be carrying at least a normal percentage of moisture. The writer has long upheld the opinion that dampening the air of a coal mine is of no practical value as a preventative to the extension of an explosion of coal dust, and this opinion is supported by the experiments of the "Explosion in Mines" committee.

As to (*b*), "explosions" of coal dust, the committee says, that each dust particle aiding in the propagation of flame is burned as a whole; i. e., that both the volatile matter, and the fixed carbon, are consumed. The so-called "pioneering cloud," which receives much prominence in the report, must originate from old dust on roadways, and is therefore less inflammable than new dust which is formed by the attrition of coal in transit. This is the most inflammable dust and floats in the air-currents supported by its own balloon of gas. This balloon of gas is provided and kept active by the escaping occluded gases. After these gases have escaped the dust falls and is deposited on the roadways, whilst the original gases are replaced principally by carbon dioxide. It will be seen therefore that the dust which forms the large part of the "pioneering cloud" is not as explosive or inflammable in a mine as the new dust. For these reasons the writer looks upon new dust as being as dangerous as explosive gases, and believes that the speed and violence of such explosions are mainly due to this fact, and not to any "pioneering clouds" of dust which necessitate a primary concussion of air before they can come into action.

The argument that a "pioneering cloud" of coal dust must be present before a coal-dust explosion originates, is disproved by the fact that many such explosions that terminated in the dustiest parts of a mine, and also by the experiments of Sir Henry Hall. In the latter instance the experiments were made in a vertical shaft; various explosives were fired at the bottom after a considerable quantity of coal dust had been thrown into the pit and mixed up in the air. On at least one occasion the first shot fired produced a violent explosion with a flame reaching 60 feet above the pit top. The second shot did not produce an explosion, but blew dust out of the shaft. The third shot, however, caused as violent an explosion as the first one, although no fresh dust was put into the pit. Under these conditions the writer fails to realize that a "pioneering" cloud of dust is a necessary part of the initiation of a coal dust explosion.

If experimental results do not agree with the demonstrations of force in actual explosions in coal mines, then it is clear that the experiments have not been made under the precise conditions of a coal mine, and they may therefore become misleading and useless.

A considerable amount of attention was given by the committee to an inquiry into the class of flame which is necessary to create a coal-dust "inflammation." Based on Doctor Wheeler's experiments, made for the Coal Operators' Association, the committee endeavored to establish as a fact, that a huge flame from gas at a pressure of 20 pounds per square inch, issuing from a jet of 2 inches diameter and producing a flame 10 to 14 feet long, and about 12 inches in diameter was necessary to ignite a cloud of coal dust, if a pioneering cloud had not first been created by air concussion. The committee says: "It may therefore be the case that after the flame has proceeded a certain distance in the ready formed dust cloud, the column of air driven in front of the flame is capable of raising the dust lying on the floor and other surfaces, and so creating an inflammable cloud, independently of any other source of disturbance." This is the theory of the "pioneering cloud of dust." The committee agreed

* Consulting Mining Engineer, Vancouver, B. C.

that this pioneering phenomena might eventually give place to "explosive combustion."

It appears, therefore, to have been proved that the coal-dust danger is non-existent, excepting where ignited blowers of gas, or blown-out shots occur under, or themselves set up, the necessary conditions.

It is morally certain that this argument is not corroborated by Sir Henry Hall's experiments already referred to, in which there were no pioneering clouds of coal dust and only a small percentage of dust in the air.

Assuming that the cloud of coal dust and concussion are the two great dangers to guard against in a dusty coal mine, we can only come to one conclusion; viz., that if blasting is shut out of a coal mine, there is only the remotest chance of a coal-dust explosion ever occurring.

Old Freibergers in America

A dinner in honor of Dr. Richard Beck, President of the Freiberg Bergakademie, Freiberg, Saxony, Germany, will be given on September 9, at 7 P. M., at the Engineers' Club, 32 W. 40th Street, New York City.

Doctor Beck has been attending the Twelfth International Geological Congress, recently held in Canada, and is now on a tour of places of interest in the United States. Doctor Beck is well known for his work in geology, especially on the subject of ore deposits, on which he has written extensively, and on which he is considered an authority.

The dinner in New York is a complimentary dinner given by Mr. F. G. Corning, a prominent mining engineer, a graduate of the famous old mining school, and a member of the alumni association, "Old Freibergers in America."

All former students at Freiberg are invited to be present at this dinner, and for particulars are requested to address the secretary, C. L. Bryden, 1701 Jefferson Avenue, Scranton, Pa.

Lignite Mining at Hoyt, Texas

Written for The Colliery Engineer

In Hoyt, Wood County, Tex., in the Timber Belt Division, the coal beds are of unusual interest. The operating company is the Consumers Lignite Co.

The coal is true lignite and brown coal, in Tertiary formation, and lies in horizontal seams between basal and silicious clays. The coal is dense, shows sharp parallel cleavage, and at some places is flecked with white spots which consist of calcareous sandstone, formed, no doubt, by lime impregnation. From numerous samples taken throughout the two mines (No. 5 and No. 6), the following is taken as an average analysis:

Moisture, 27.24; volatile matter, 32.64; fixed carbon, 29.16; ash, 10.13; sulphur, .78. British thermal units per pound lignite, 7,716. Thus, it is seen that the coal is of a quality considerably above the average.

The low natural moisture and the absence of surface water tend to make most of the heat value available for creating power. The lignite is comparatively low in ash, while the thermal value of the lignite as it comes from the mines is comparatively high. The high volatile content, as well as the high fixed carbon, should make this particular lignite especially adaptable for producing artificial gas of high thermal value, and it should not clinker, nor in any way stop up the producer. The low sulphur content minimizes the destruction of grate bars, caused by the formation of iron sulphide, which always occurs when iron is heated to a red heat in the presence of sulphur.

The main entry in both mines runs almost due north from the mouth of the mine, and the coal is reached by an incline of about 15 degrees. Both mines are unusually dry, being free from underground infiltrations, and also from surface water. This fact is especially beneficial to both miner and consumer.

Fig. 1. Lignite Mine in Texas

Very little timbering has been required, due to the method of mining, except at the inclines and at the partings, where heavy timbering is done, as shown in Fig. 1. The props are stood vertically in the coal and the collars are sawed lengths reasonably close together. One will note by looking at the cut that the props sunk in the ribs out of the way are tied by planks. Attention is called to the sag in the collars which always occurs in wide places where timber is used. Where work of this kind is permanent steel beams are more serviceable and less costly in the end.

The mines are worked by hand drilling and black powder blasting. The coal is worked out from the floor to approximately within 6 inches of

the hanging wall, leaving a solid lignite roof, which assures a clean coal and minimizes the danger of falling roof.

There are three methods of transportation used, cable and mule haulage; gasoline locomotive and cable haulage; and the steam hoist at the tipple. The coal is hauled from the more remote parts of the mines to the main entry with mules, where a trip is formed, which is taken by the gasoline locomotive to within reach of the hoisting cable at the base of the incline, up which it is hoisted to the surface and loaded on to the railroad cars through chutes. The gasoline locomotive, made by the Milwaukee Mfg. Co., has 30-inch gauge, and is capable of hauling 10 mine cars at a time, with an average load of about 4,500 pounds per car. One will note from the accompanying figure the distance between the tracks at the base of the incline, a feature which minimizes the possibility of accidents by being squeezed between the two trips.

Ventilation is accomplished by the fan and furnace method, and while it is already efficient, additional fans are being added. Up to the present time no gas of any description has been encountered.

A toy company at Sheboygan, Wis., started out to use only the waste wood from other mills. It has worked out a system of using all small waste pieces so that practically nothing but the sawdust is lost.

Electrically Driven Compressed Air Plant

Written for The Colliery Engineer

The need has been felt in colliery work for an apparatus which will combine the use of the compressed air drill with the advantages of electric transmission. The difficulty with regard to compressed air used alone is that leaks, especially in mines where acid water is present, are apt to form in the pipe line and any leak means considerable waste of energy. There are also condensation troubles and other defects incident to the long distance transmission of air. Electric power has been quite generally introduced into the collieries in this country, but the fact remains that compressed air systems are very largely used, particularly in Great Britain.

Under these circumstances, a method which has been adopted in order to utilize the advantages of each system is interesting. In the method under consideration the air is compressed by means of a small portable compressor, and the power for working these compressors is obtained from an electrical distribution system. An example of this kind of equipment is shown in Fig. 1, which represents a portable compressor outfit made in England. The outfit consists of the motor, the compressor, and the air receiver. The compactness of the arrangement makes it possible to move it from place to place on the rails which are used in ordinary colliery work. The motor is of the rain-proof type and drives the compressor through a simple form of gearing. The bedplate of the compressor is provided with four flanged wheels on which the machine is moved from place to place, but these wheels are removed before actually running the machine, this operation being rendered easy by the fact that they are mounted on axles which fit into the grooves on the under side of the bedplate. The compressor is a single-stage quadruplex, having four single acting cylinders each fitted with a trunk piston arranged radially in a circular-shaped casing, the four pistons being driven from the same crankpin. The compressor thus consists of four single acting units, all delivering into one common air duct in the casing. In this way extremely efficient water-jacketting is possible, inasmuch as by employing four comparatively small cylinders instead of one large one for compression, more of the air is brought into contact with the cooling surface than would be possible with a single cylinder of equivalent capacity. In the larger sizes of compressors each piston is fitted with a balance piston, the office of which is to keep the machine in constant thrust. This is one of the features of these compressors, and insures silent running even after considerable wear has taken place.

These compressors have no inlet valves, air being admitted to the cylinder from the compressor casing through ports in the top of the connecting-rod gudgeon, which coincide with similar ports in the piston.

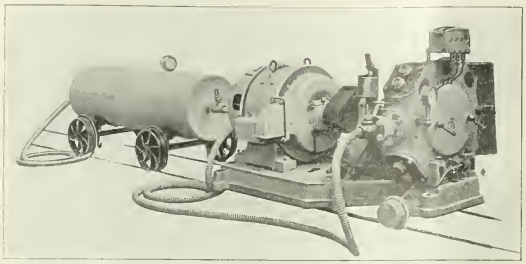


Fig. 1. Electric Air Compressor

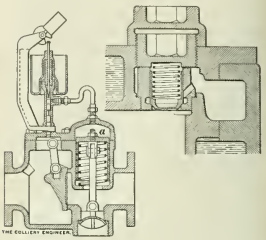


Fig. 2 Fig. 3

When nearly at the end of its stroke the piston overruns the additional ports cut in the sides of the cylinder, in this way placing the cylinders in direct communication with the inside of the casing which forms the inlet chamber. By this arrangement considerable saving in volumetric efficiency is claimed as compared with any compressor having spring loaded inlet valves. The delivery valves which are fitted at the outer end of each cylinder are of the spring loaded kind. They open during the compressing stroke as soon as the air has reached the required delivery pressure and through them the air passes to the delivery passage from which it may pass away through four openings which are provided. Fig. 3 shows a section of the valve. The machine is fitted with the unloading device shown in Fig. 2, which takes the form of a by-pass valve forming a connection between the delivery and the atmosphere. It is controlled by an air relay connected to the reservoir so that when the air reaches the desired pressure the by-pass valve opens and the delivery chamber is put in communication with the atmosphere. In this way the load is automatically removed from the motor, thereby economizing power. As soon as the pressure falls to a predetermined point the valve closes and the compressor commences to deliver air again. As these compressors are run in a mine atmosphere which may contain a considerable amount of coal dust, an air filter is added in order to insure that dust shall not enter the intake chamber of the machine. This plant is suitable for working one drill but when it is desired to work several drills from one compressor, larger machines with single- or double-stage compression, but of same general design, are used.

Carrying the Meridian Underground

*By W. H. Roberts, Jr.**

The method of shaft plumbing described below is applicable when there are two shafts opening into the same seam. It is, in many respects, simpler than the two- or four-wire methods, there is little chance of error, and the results obtained are very satisfactory.

Field Work.—One wire is hung in each of the two shafts, A and B. A surface survey is run from the wire in A to the wire in B, and the survey tied to the true meridian. Similarly, a survey is run from wire to wire underground, magnetic bearings being carefully taken and recorded. In practice it is generally impractical to run these surveys while the wires are suspended in the shafts, hence, points are set near the shafts both above and below ground and the surveys between these points made in advance, so that it is only necessary to connect these points to the wires when they are suspended. It greatly facilitates the work to have two parties on the job, one on the surface, the other in the mine. It is highly advisable that tie surveys be made if possible, both on the surface and underground, as these offer an excellent check against errors in the length of the line.

*San Bernardino, Calif.

Calculations.—From the surface survey, using the wire in A as origin of coordinates, calculate the length and true bearing of the line joining the wire in A to the wire in B. Let us assume this as L, on a course N 13° 32′ W. Then referring to Fig. 1,

Length A to $B = L = \sqrt{N^2 + W^2}$

N = total latitude and

W = total departure calculated from true meridian.

$$\text{True bearing of } L = N\left(\tan^{-1}\frac{W}{N}\right)W$$

From the underground survey, Fig. 2, with same origin, construct a trial traverse sheet using the magnetic meridian (allow for declination) as basis for calculated courses. Calculate the length and bearing of the line from wire A to wire B from the trial traverse sheet as follows:

Length A to $B = L = \sqrt{N'^2 + W'^2}$

N' = total latitude and

W' = total departure calculated from trial Traverse Sheet

$$\text{Trial course of } L = N\left(\tan^{-1}\frac{W'}{N'}\right)W$$

This length should of course be the same as L, the inequality being due to any errors in survey. The course will vary probably several degrees from the surface line. The difference between it and the true bearing of the calculated line on the surface is the correction angle to be applied to the calculated courses of the mine survey to bring them to true bearing. Thus, assuming it to be N 15° 45′ W, the correction would be 2° 13′ to the right to be applied to all courses on the trial traverse sheet to put them on a true bearing.

The advantage of this method lies

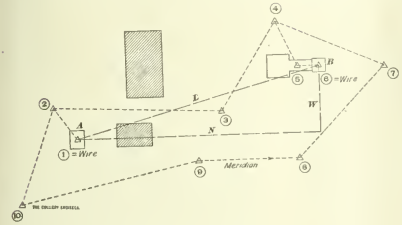


Fig. 1. Surface Survey

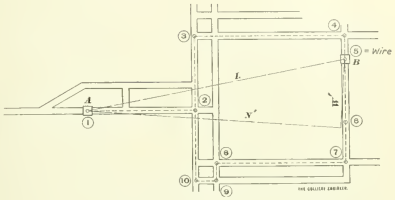


Fig. 2. Underground Survey

in the fact that it gives a base line from several hundred to several thousand feet long. Then, too, a slight vibration of the wire will produce no appreciable error in the work. The usual caution must of course be observed in swinging the wire, that it hangs free. If the wire be rolled on a reel and taken to the

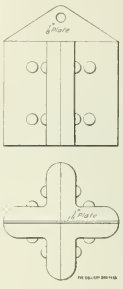


Fig. 3

shaft bottom, the loose end fastened to the cage and hoisted slowly, the wire can be more easily kept free of kinks than by lowering the weighted end from the surface. In the fan shaft a cord can be let down and used in place of the cage. For a 600-foot shaft, use No. 18 galvanized wire and a 30-pound plumb-bob. Copper wire is superior to the galvanized, but a slightly lighter bob must be used. A very satisfactory form of bob is shown in Fig. 3, and can readily be turned out by any blacksmith on short notice. It can be made of any odd piece of 3-inch or 4-inch angle iron and a small piece of $\frac{1}{8}$-inch plate. Dimensions depend on the size and weight of the angle iron used. This form of bob offers greater resistance to spinning than an ordinary round one.

Waste in Coking

Practically 10 per cent. more coke is made from coal in a by-product oven than in a beehive oven. As 32,868,345 tons of coke were made in beehive ovens in 1912, 3,286,834 tons of coke, valued at $8,217,085, were wasted.

Explosion-Proof Motors

In Bulletin No. 46, United States Bureau of Mines, Mr. H. H. Clark gives the results of experiments with electric locomotives with a view to ascertaining if those termed "explosion-proof" could be safely used in gaseous mines.

The term "explosion proof" refers to a motor enclosed by a casing so constructed that an explosion of a mixture of firedamp and air within the casing will not ignite a mixture of the same gas surrounding the motor.

Of the two kinds of explosion-proof motors, one kind totally enclosed is built strong enough to withstand high internal pressures and so designed that the efficiency of all enclosing covers can be satisfactorily maintained; the other is provided with relief openings or valves designed to relieve the pressure of an explosion within the motor casing and to cool any products of combustion discharged through the valves.

On account of the cost of construction, attempts to make motors explosion-proof have been confined chiefly to those motors having relief valves.

The function of explosion-proof devices for electric motors is to reduce below the ignition point of gas (methane) the temperature of any flames that may be discharged from the motor casing. The temperature reduction is effected by removing the requisite amount of heat from the flames during their passage through the devices. Various plans have been proposed and developed for extinguishing the flame from the explosion. The principle of the Davy safety lamp has been the basis of most of the protective devices designed for explosion-proof motors. The application of this principle consists in causing the discharged gases to pass over or through metallic plates or screens which by conduction remove the heat from the gases. In some of the devices the cooling effect of expansion is also utilized. Five motors were tested, no two being protected in exactly the same manner, and in Bulletin No. 46 the results of the tests are described in detail.

According to the definition of an explosion-proof motor, such a machine can presumably be safely operated in an atmosphere containing gas (methane) under conditions most conducive to explosion, provided that the protective devices with which the motor is equipped are in good condition and in their proper places. In conducting the investigation, an effort was made to produce conditions that would probably introduce the greatest elements of danger. In the earlier tests especially, and to some extent in subsequent tests, it was not evident just what the most dangerous conditions would be.

American Mine Safety Association

The annual meeting of the American Mine Safety Association has been called by H. M. Wilson, chairman of the executive committee of the association, to take place September 22-24, at Pittsburg, Pa.

The program in detail is as follows:

September 22: 10 A. M., meeting of executive committee in Building 9, Bureau of Mines, 40th and Butler streets. 2 P. M., mine-rescue and first-aid contest, Arsenal Park, Pittsburg. 8 P. M., reception of members by executive committee and motion-picture lecture on mining industry.

September 23: 9:30 A. M., opening session of association. Report of executive committee action on constitution. Appointment of nomination and other committees. 3:45 P. M., explosion in experimental mine near Bruceton, Pa. Leave B. & O. depot, Smithfield and Water streets, by special train. Explosion at 3:45 P. M.; returning, arrive Pittsburg 5 P. M. 8 P. M., nomination and other committee meetings.

September 24: 10 A. M., business session. Election of officers. Miscellaneous business. Adjournment. 2:30 P. M., visit Experiment Station, Bureau of Mines, 40th and Butler streets, and other points of interest.

Moving Pictures

As an Aid to Mine Accident Prevention—Illustration of Safe Methods and the Results of Unsafe Ones

Written for The Colliery Engineer

In pursuance of his strenuous efforts in the line of mine accident prevention, Mr. Thos. Lynch, president of the H. C. Frick Coke Co., the United States Coal and Coke Co., and other subsidiary coal companies of the United States Steel Corporation, conceived the idea of using moving pictures in an educational campaign among the mine workers, and the idea is now being carried out.

After Mr. Lynch had thoroughly thought out the scope which he wished to cover with these pictures, he turned the matter over to Messrs. W. H. Clingerman, general superintendent; J. P. K. Miller, chief engineer; and Austin King, chief mine inspector, all of the H. C. Frick Coke Co., for development. Mr. King was given full charge of the development and spent the better part of a year in taking thousands of pictures of various accidents as they happened, sham accidents, and conditions where accidents had occurred previous to the time he began this work. After the selection of the pictures to be shown, they were exhibited at all the mines, some 60 in number, of the H. C. Frick Coke Co., located in Westmoreland and Fayette counties, Pa., including the towns of Connellsville, Scottdale, Mt. Pleasant, and Uniontown; also at the mines of the National Mining Co., in Allegheny County, Pa., in Pittsburg for the benefit of the Mining Institute; at the mines of the United States Coal and Coke Co., thence to Vivian and Welch, W. Va., for the benefit of the miners and mine operators there. They were then taken to Indiana and Illinois to be exhibited at the mines there, after which time they will be rearranged with some moving pictures that are now being made by the United States Coal and Coke Co. These moving pictures show the safe and proper way to perform the various operations of each occupation inside and outside of the mines and will be shown again over the same ground, for the purpose of impressing upon the workmen the necessity of making "safety the first consideration." Photographers from the Government Bureau of Mines, Department of the Interior, are doing this work, and it is being done very thoroughly. It is expected they will be of great benefit to the mining world, both for the conservation of life and from an economic standpoint.

All the coal mines under the jurisdiction of Mr. Lynch produce more than half as much coal per annum as does the state of West Virginia, and notwithstanding the fact that this coal is mined largely from shaft and slope mines, some of which are very deep and very gaseous, the number of men killed per 1,000,000 tons of coal mined is much below that of any mining country. These results have been brought about by constant vigilance, strict application, and the adoption of every known safety device for the inside, the outside, and around the mines. Mr. Lynch believes that to be successful in preventing a large number of mining accidents, it is necessary to have the cooperation of every workingman and boy who works in or around the mines, and these pictures are exhibited to show the proper way to perform the dangerous operations in coal mines, and the fatal results of carelessness on the part of workmen, in hopes of further interesting the employes and making them more careful, and thereby further to reduce the number of accidents, both fatal and non-fatal.

The first slide shown was "Safety First," the slogan of the United States Steel Corporation; then a photograph of Mr. Lynch; a report of fatal accidents of the H. C. Frick Co. for the years 1910, 1911, and 1912, as well as a comparison between the fatal accidents of Scotland, South Wales, and all of Great Britain and the H. C. Frick Coke Co., which showed as follows: Deaths per 1,000,000 tons of coal produced for the year 1912: Scotland, 3.50; South Wales, 6.52; all of Great Britain, 4.52; H. C. Frick Coke Co., 1.88. Tons of coal produced per fatal accident: Scotland, 285,000; South Wales, 153,000; all of Great Britain, 248,000; H. C. Frick Coke Co., 531,328. Deaths by falls per 1,000,000 tons mined: Scotland, 1.86; South Wales, 2.79; all of Great Britain, 2.03; H. C. Frick Coke Co., .70.

The H. C. Frick Coke Co. produces twice as much coal per fatal accident as the bituminous field of Pennsylvania, Ohio, and Illinois; three times as much as West Virginia and South Wales, and over twice as much as the whole of Great Britain.

The pictures were arranged in series, showing both the safe and unsafe way to perform various occupations in connection with coal mining, as well as the results from the unsafe methods. The series shown were as follows:

A shows a man making a proper test of the roof before starting to work in the morning and setting his posts, making his place safe. It then shows a man who fails to make the proper test and set his posts and is later killed by a fall.

B shows a man who discovered his working place to be dangerous and put up a danger board before he came out to report it to his boss; while he was gone, a man comes up, but seeing the danger board, does not go into the place. This is followed by a man who finds his place dangerous and comes out to report it to his boss, but does not put up a danger board; while he is gone, another workman comes along, sees no danger board, goes into the place and is killed by a fall of slate.

C shows a man working in high coal which he cannot reach with his hands, so he uses two picks to make a safe test of the roof and sets sufficient timber to protect himself; it also shows a safe block for the mine car on the grade.

D. The first part of this series shows a man breaking a place off where the draw slate is overhanging and he supports it and is working in safety; the second part of the series shows the man breaking a place off where the draw slate is overhanging, but he neglects to support the slate and is killed by a fall. This series also shows two entry men cleaning up an entry, having the draw slate well supported while they are cleaning it up; after the entry is cleaned, they try to take down the draw slate but cannot do it; they then go to work without posting the place, thinking it is safe because they are unable to take it down. A little later the slate falls, killing them.

E. The boss finds a place not properly posted and marks the places where posts are to be set. The careful miner then sets his posts and works in safety. The second part of the series shows a careless miner, who did not set his posts as instructed by the boss, and is killed by a fall.

F. The boss discovers a slip and tells the man to set a post and put in a cross-bar. The man was not very trustworthy, and the picture shows the boss staying with him to see that the post is set and cross-bar put in.

G shows a man making a very careless test of the roof between crossbars with a pick and depending on the sound when striking the roof between the pieces to determine as to whether the place is safe or not. This careless test fails to show the roof unsafe and a little later the man is killed by a fall.

H shows a man working in ribs setting an extra line of posts to provide a safe retreat when he makes a fall. The second part of the series shows a man making a fall, who has not provided a safe retreat and is caught by the fall.

J shows a man tamping a shot in a machine-cut place with clay—the proper tamping—and the results of the shot. This is followed by a picture showing a man tamping a shot in the same place, using coal dust, and the shot firer is burned very badly by a blown-out shot. This series also shows the shot firer discovering a hole not properly drilled and refusing to charge it but reports it to the boss.

K shows the boss discovering a dangerous place on a haulage road and points out the dangerous spot to the timber men. It also shows the workmen testing it to see where to set a temporary post to support the slate while they are trimming the place and making it safe. The second part of the series shows a man making a careless test of a dangerous spot, which does not show the dangerous place, then he goes ahead to trim up the side without setting temporary support and is killed by a fall.

L shows the safe and unsafe way of hanging danger boards on temporary and permanent obstructions in dangerous places.

M shows the safe and unsafe method of setting posts and crossbars.

N shows safe and unsafe way of sluing cars around curves and the fatal results of improper methods.

O shows the safe and unsafe method of carrying any steel instrument along a motor road and the danger connected with the unsafe way. It also shows how the trolley should be guarded.

P shows a piece of bad track in the mine and its result; how cars become derailed and many men injured by heavy and useless lifting, as well as time lost.

Q shows the unsafe way of drivers riding trips and the result.

S shows the safe and unsafe way of blocking cars in dip headings, and the danger resulting from the unsafe methods. It also shows a drag on the back end of a loaded trip to derail it in case it starts backward.

T shows the safe and unsafe way of blocking cars on a grade, and the danger resulting from the unsafe methods.

U shows the safe and unsafe way to clean the track in front of wheels of a trip, and the results of the unsafe methods.

V shows a careful man on a motor road, who is always on the alert and always getting in a place of safety when a trip approaches. It also shows a careless man, inattentive to the noises around him, who is caught by a trip. This series also shows two men disputing which way to go out of the mine; the careful man taking the manway and the careless one taking the haulage, and is killed before he gets out of the mine.

W shows the safe and unsafe way to couple cars on a curve.

X shows cars on a motor trip being derailed and the proper position of the brakeman in giving signals to the motorman to have cars slued on the track. It also shows the unsafe way and its result.

Y shows a careful driver observing danger signals and a careless driver disregarding them, which results in death to his animal and himself.

Z shows a safety device on coal-cutting machines and the dangerous result of removing the device.

There were also a number of views shown of special features of the United States Steel Corporation, including trained nurses taking care of the sick; first-aid team which won first prize at the International Red-Cross Convention at Washington; swimming pools and playgrounds for the children, etc.

With the view of making the exhibition amusing as well as instructive, a reel of comic moving pictures entitled, "That College Life," was shown. One showing the result of disregarding the safety devices, and a number of panoramic views of the various plants of the United States Coal and Coke Co., at Gary, as well as a reel of moving pictures of the parade, first-aid contests, and various other athletic contests on the Fourth of July, were shown.

"Suppose Miner"

Suppose you keep a diary of the careless things you say,
And the careless acts you're doing in the hustle of the day;
Suppose you keep a diary of the dangers you pass through;
Don't you think that it might help to make a careful man of you?

—*E. A. Schubert.*

How to Handle a Dry or Dusty Mine

Recommendations for Eliminating Conditions in Dry Mines that Experience Has Shown to Be Dangerous

By David Victor*

ALTHOUGH from 10 to 15 years ago some of the best chemists and mining men of both this country and Europe were of the opinion and were advising the mining world that coal dust was playing an important part in the various mine explosions which were happening with more or less regularity, it took the great Courrieres disaster in France, and a few such as the Monongah, Red Ash, and Lick Branch in West Virginia, and the Marianna, in Pennsylvania —to which a number of smaller ones could be added—to thoroughly convince the mining world that coal dust is one of the most dangerous elements that confronts them.

After having agreed that this was the case, it became the duty of all parties interested in mining to adopt measures and make recommendations that would eliminate or reduce the recognized dangers, hence, the topic of this paper.

You may ask why the words dry and dusty are both used in naming the subject. In answer to which I will quote from a paper by Mr. Frank Haas, consulting engineer of the Consolidation Coal Co., which was read before the West Virginia Coal Mining Institute, at Charleston, W. Va., October 7, 1908. Mr. Haas says:

"By dust I take it is meant such particles of coal as are transported from their original position by the air-currents. The size of the particles so affected will vary with the kind of coal and the velocity of the current. The term 'dust' has, in past literature, had a very loose definition, in fact, a satisfactory one has not been discovered.

"There seems to be no results of any experiments reported giving the exact size of coal particles which are maintained in suspension by air-currents of certain velocities. However, this need not enter into the discussion, as we know that in case of an explosion there is no discrimination as to the size of the particles affected. In fact, I am satisfied in my own mind that the bulk of the force of the Monongah explosion originated in the solid coal."

An explosion is defined as rapid combustion. How rapid it does not state, but we know that it must be almost instantaneous.

If it were possible to get ten parts of air by weight in immediate contact with one part of coal, an explosive mixture would result. This, however, is impossible, as one volume of coal by weight is equal to 1,065 volumes of air by weight; it would, therefore, require 10,650 volumes of air, each particle of which is to be in immediate contact with one volume of coal. Furthermore, the temperature of volatilization of coal is less than that of ignition, therefore, coal dust would become coal gas and coke before the temperature, where explosion is possible, is reached.

The argument then is this: That the explosions which are attributed to coal dust are really explosions of coal gas. This being the case you will readily see how the exceedingly dry condition (although dust is not much in evidence) will serve to propagate an explosion that is once started.

Air being a necessary element for an explosion, coal, and coal dust are always in excess, and the amount of gas that could be given off is incalculable. The air, however, is limited and the quantity is readily determined by a measurement of the volume of the mine from which coal has been displaced if the roof is intact. From this it can readily be seen that the quantity of dust or coal is really the measure of the magnitude of an explosion.

This is a question that has been thoroughly investigated by individual, corporation, and government interests, and while there is a varied difference of opinions as to the remedy to be applied, they all agree to the essential points: That when dust is dry it is constantly being carried about the mine in the mine atmosphere, with the result that the fresh dust from the working faces is joined by the dust and gases from the miners' shots and the dust from the haulage roads, always kept fresh by the daily spilling of fresh coal from the cars and the pulverizing of same by the traveling of miners and mine stock and the grinding of motors and motor trips passing along the haulways. This dust is carried and deposited in all sections of the mine, where it only needs the shock of a blown-out shot and the accompanying flame to do the work.

To prevent this condition, a number of appliances have been established, all of which do more or less good. But as a general rule they attempt to keep the mine moist by the local application of water to the dry parts, either by the use of water cars or sprayed from water pipes where pressure is maintained for this purpose. The inefficiency of these methods may be demonstrated as follows:

Let us assume that a mine circulates 100,000 cubic feet of air per minute. A test for humidity or the intake current shows dry bulb 32 degrees, wet bulb 29 degrees, which shows the air to only be carrying 25 to 29 per cent. of its capacity of moisture. This amounts to 2.497 gallons per 100,000 cubic feet per minute.

This same volume of air coming from the mine fully saturated would give the following test:

Dry bulb, 60 degrees; wet bulb, 60 degrees; which shows the air to be carrying 100 per cent. or its full capacity—which amounts to 9.843 gallons per 100,000 cubic feet per minute. This would mean that this air-current was carrying from this mine 9.824 gallons − 2.497 gallons = 7.327 gallons per minute, or 10,578.24 gallons per day, which has to be made up in some manner if the

*Chief Mine Inspector, Consolidated Coal Co., Fairmont W. Va. Abstract of paper read at Kentucky Mining Institute summer meeting, 1913

mine is not to become very dry; and if provision is not made for this supply the air is circulating through the mine in a very dry state and in good condition to take up, transport, and keep in circulation, the largest amount of dust, which is a most dangerous condition from a dusty mine standpoint.

In summing up the dangers of dry and dusty mines, a number of tests of the National Bureau of Mines at the government mine at Pittsburg, Pa., clearly demonstrated to us that all that is needed to have a serious explosion is a mine, some dry coal dust, and a flame.

The mine, being a part of one of the great industries of the world, must be kept in operation and should be made safer than our mines have been in past years. To accomplish this, a contact of the flame with dust necessarily generated in the daily operation of a mine must be as far as possible removed, and then each kept in such shape that if contact happens the least possible amount of damage will result.

Usually the starting point of an explosion is the blown-out shot or the improper storing or handling of explosives in the mines. To prevent this needless possibility of flame, I offer the following suggestions:

See that the coal is properly mined —generally the depth that the coal to be blasted is high.

See that the holes are properly drilled—and last see that no more than the prescribed amount of any explosive (permissible preferred) is used to bring down the coal.

A charge limit of 2.5 pounds of black powder or the equal thereof in strength of permissibles should be the maximum charge. When the coal is too thick to be broken with the prescribed explosive it should be shot in two benches, the lower bench being shot and loaded out before the upper bench is shot.

All heavy rock shooting or work which requires the use of dynamite should be done when all miners are out of the mine—only enough men being allowed in to actually do the work at hand.

In addition, care should be exercised in the hauling, handling, and storing of explosives. Under this head comes the improper handling of explosives in trips of cars propelled by electricity; the miner making up his cartridge of black powder with a lighted pit lamp in his cap; the miners storing whole boxes of explosives and detonators together near their working places; all these and more loose practices around the mines should be strictly prohibited and unless we can enforce such discipline as will tend to remove the cause for initial explosions we cannot hope for much prevention along these lines.

Only this morning (April 15, 1913) I read the report of an accident as follows: "Dynamite lets go in a Pennsylvania mine and three men are badly injured." These men were about to stop work to eat their meals when the explosion happened. The explosives used were carried in an open tin bucket and one of the men is said to have hastily thrown a battery used in discharging dynamite caps into the bucket, causing the explosion. With real dry surroundings here then was the initiative for a bad dust explosion, which should by all means have been prevented.

And to prevent the existence of dust or dry conditions that might lead to the generation of dust and gas when, from any cause, a large flame is created in the mine, I would offer the following:

Coal dust has the property of absorbing moisture and holding it when surrounded by favorable conditions in the atmosphere.

A direct mixture of dust and water is very difficult and practically impossible. It appears that the time element has considerable to do with the absorption of moisture by dust, and a moist atmosphere is necessary for it to retain water so absorbed. In a series of experiments it was found that in a normally dry mine the dust contained about 1.5 per cent. water, while in a mine where the air was held to its highest point of saturation the dust contained from 4 per cent. to 25 per cent. moisture. For all practical purposes it is immaterial whether the water is chemically or mechanically held, its effect is the same and the quantity is surprisingly large, which is a fortunate circumstance. If such conditions can be maintained uniformly throughout a mine a very formidable obstacle, if not preventative, is placed in the way of explosions of coal dust.

Water by direct application, such as the water car, the use of hose and nozzle or other spraying apparatus, is obstinately resisted by coal dust. Water vapor has the property of greater penetration than the liquid, hence it appears more practical to apply the moisture in this form.

A saturated atmosphere at a high temperature would be the most efficient method. Saturation to a certain degree can be attained, but the temperature of a mine is fixed beyond certain points on the intake airways by the temperature of the surrounding strata. A change in this temperature would be impractical, so the best thing to do is to maintain the normal temperature of the mine and hold the air at its highest point of saturation, which in practice would mean about 85 per cent. to 90 per cent., when each 100,000 cubic feet of air would be carrying about 8.5 gallons of water per minute.

As has been previously stated, several methods have been used to produce the moistening effect desired, and while all of them do some good the method that has proven most satisfactory to us is the use of steam in the intake airways. Where we have the opportunity we use the exhaust steam from fan or other engines located near the pit mouth. When this is not sufficient we use live steam from the boilers, and in a few cases we are erecting boiler plants for the sole purpose of furnishing heat and moisture to the mine air.

I am a great believer in preventatives and I think the success attained in the last few years in preventing these explosions has come about by the concerted effort of the mining departments of the states and the United States with the operators and miners in general.

I think each operator should provide instruments at his mines, such as the thermometer, barometer, psychrometer, anemometer, and water gauge, for the purpose of determining conditions in and around the mines with reference to temperature and atmospheric pressure, moisture quantity, and mechanical pressure of the mine atmosphere. Then he should join with the State Mining Department in an effort to educate his mine superintendents and mine foremen in the use of these and other instruments in order that they may be able to determine the conditions existing and know how to apply the necessary remedy in their particular mine.

The American mine owner and operator is willing to spend all kinds of money for safety appliances and is thoroughly awake to the dangers to be encountered in the operation of his mines, but there is one thing that is responsible for more accidents in mining than probably all other causes put together—that is the lack of discipline, which shows up so plainly in the lists of accidents compiled for the year. We all recognize the danger of shooting coal from the solid—we have legislated some laws along this line—but still coal is shot from the solid.

We all believe that a limit should be placed on the amount of explosives that may be used for one shot, yet we never fail to find men using as much as five to ten sticks of dynamite or 5 pounds or more of black powder for a shot. These, of course, are the exceptions, but it is usually the exceptions that are the most frequent causes of all our troubles in the mines.

We all know it is wrong to have men riding loaded trips promiscuously through the mines, but for fear we will adopt some rule that will lose us some men we allow good rules to be violated. And unless a concerted effort is made by all concerned we will still have practices going on in the mines each day that under the proper circumstances would put us out of commission with a mine explosion.

The Brookside Mine Disaster

An Account of the Accident—Rescue Work—Acts of Heroism—Condition of the Mine—Evidence of Gas Explosion Missing

By William Z. Price

THE East Brookside mine is located in the extreme western end of Schuylkill County, Pa., on the Philadelphia & Reading Railroad. The mine openings are high up on the side of Big Lick Mountain above the town of Tower City. The mine is owned and operated by the Philadelphia & Reading Coal and Iron Co.

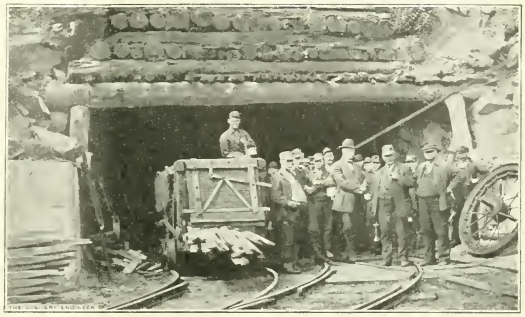


Fig. 1. Mine Officials and State Mine Inspectors at Mouth of Slope, Brookside Colliery

The explosions resulting in the death of 20 men occurred at two distinct times, one at about 11:20 A. M. and the second about 20 minutes later, on Saturday, August 2, 1913. The watch of one of the first rescue party was stopped at 11:43, so it is supposed that is the exact time of the second explosion. Both explosions occurred in No. 5 seam gangway on the fifth lift of the tender slope.

A tunnel was being driven south from the Lykens Valley No. 4 seam, to the shaft, to provide a more direct haulageway for all the coal mined on that level. This tunnel was being driven by the Portland Contracting Co., and there were 187 pounds of dynamite belonging to the contractors at the point *C*, shown on Fig. 2, the area of the tunnel being 10 ft. ×16 ft. About 175 pounds of dynamite were required to make the usual cut of 8 feet.

The disaster was at first thought to be due to an explosion of this dynamite, but the finding of the entire 187 pounds intact, under the fall, proved that such was not the case.

Owing to the excellent ventilation maintained at the mine, and its fine condition generally, no one for an instant thought of a gas explosion. In the absence of any other cause, it is possible that it was due to gas, yet there are no visible evidences of such results to timbers, etc., as usually follow an explosion of firedamp. The whole affair is shrouded in an air of mystery, which, at this writing has perplexed all the officials and experts connected with the mining company and the State Department of Mines.

As is shown on Fig. 2, the Tender slope in the No. 4 seam has a depth of 1,550 feet from the surface to the fifth lift. It starts with a pitch of about 70 degrees at the top, and changes to 60 degrees at the fifth lift, on which the accident occurred. West of the slope, in the neighborhood of the scene of the

explosion, the dip of the seam is 50 degrees.

The No. 5 seam is 12 feet thick and the coal is of a shelly nature so softthat in removing the debris in that gangway it was necessary to forepole, square forepoles being used. The No. 4 seam is about 6 feet, with a harder grade of coal.

At the time of the first explosion, Thomas Behney, a company miner, working around the Tender slope on that lift, telephoned to the hoisting engineer that an explosion had occurred in the tunnel and that he with four others were coming up for safety where he was. He died a week later. One man died while being taken up the slope, and another on his way to the hospital, thus wiping out the entire first rescue party.

Daniel Morgan, a shaftman, and three others, after seeing the smoke come out of the upcast following the second explosion, went down and got the three men out who were still alive. This was a difficult and extremely dangerous task as the coal and debris were falling all around them.

The headquarters of the company at Pottsville were notified about 12:15 there, they started back through a tunnel to the No. 5 seam and then eastward toward the new tunnel and the slope.

At breast 60 they found Lorenz who had then crawled some distance. They carried him to the turnout at Breast 46 and then Fegley went out for help. Returning later he brought Division Superintendent Kaercher, and a party of 13, including helmet men. After Lorenz had been carried out, Messrs. Kaercher and Price accompanied by two helmet men started east to find Farrel, the mine foreman. They got as far as the

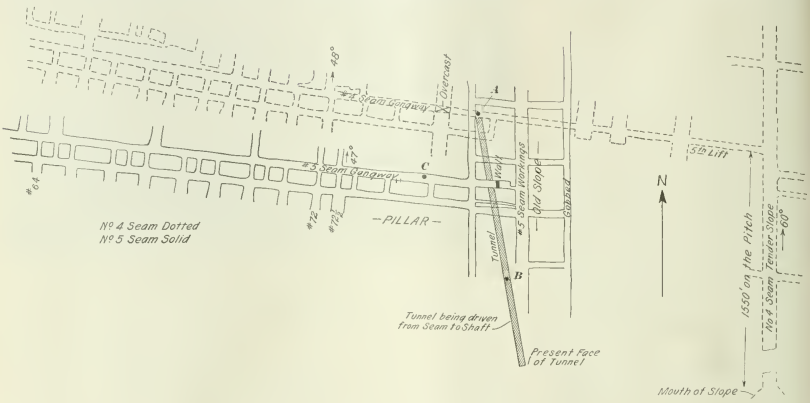


Fig. 2. East Brookside Mine Workings. Scale 1 inch = 200 feet

lamps and help, to investigate what had happened. On their way up they picked up another man on the slope and took him along to the surface. At the mouth of the slope, Fig. 1, they met fire bosses Murphy and McGinley, and Schoffstall, a night inspector, making nine in all. This group of men descended the slope and walked along the No. 4 seam gangway 600 feet to the tunnel. Just as they got to the mouth of the tunnel at the point *A*, Fig. 2, the second explosion took place, killing six of the men instantly. Schoffstall was found at the overcast 50 feet beyond the tunnel, calling for help. It is presumed he was in the lead and walked beyond the tunnel before realizing and at 12:30. Division Superintendent Kaercher started for the scene. The company rescue car was ordered to the mine immediately.

Mine Inspector C. J. Price was notified at his home at Lykens at 12:30 and was rushed in an automobile to the scene at once and descended the slope shortly after 1 o'clock. He immediately placed Outside Superintendent J. H. Lee in charge at the slope, and accompanied by a miner, Charles Fegley, started in No. 4 seam gangway to look for John Lorenz, the district superintendent, and John Farrel, the mine foreman, who were supposed to be in the vicinity of No. 3 plane, over a mile west of the slope. Not finding them door on the gangway between breasts 62 and 63, but owing to the condition of the atmosphere the helmet men alone were able to proceed further; these men found Farrel about breast 65 and then Superintendent Kaercher and Inspector Price set down their safety lamps and ran in and helped them carry Farrel out, as he was a very large man.

No. 5 seam gangway was caved tight from the tunnel to breast 72, a distance of about 285 feet. It was under this cave that fire bosses Farley and Fessler were caught. Farley's body was recovered Friday morning, August 15, and Fessler's at 10 P. M. They were found about 160 feet from the tunnel.

Debris was found 250 feet east and west of the tunnel in No. 4 seam gangway, completely demolishing the overcast and knocking out 16 props on the high side of the gangway east of the tunnel.

On no object in the vicinity of the explosion, nor on the timber, is there any evidence of the flame of a gas explosion. The two doors in No. 4 seam gangway, 400 and 475 feet, respectively, from the tunnel had one board blown off each, but were otherwise unharmed. A mule was standing a few feet from the slope on the same roadway, but was untouched. A coil of 1½-inch hemp rope frayed out for 2 feet from the end was not even singed and it was lying alongside of the roadway in No. 5 seam at breast 71.

The workmen in the tunnel were all found at the point *B*, Fig. 2, about 200 feet from the No. 5 seam gangway. Had they stayed in the face of the tunnel they would have been unharmed. They were loading a car at the time of the first explosion and on going out, probably to investigate what had happened, were caught in the second. Their dinner pails, resting on a pile of mine ties about 100 feet from the face of the tunnel, were untouched. A 3-inch compressed air line was blowing directly in the face all the time. The air was at 110 pounds pressure and assured the workers in the tunnel fresh air at all times. The face of the tunnel is about 600 feet from No. 4 seam gangway. The brattice in the tunnel was intact for about 300 feet back from the face.

A peculiar thing about the explosion is the fact that the bodies of some of the men were quite severely burned through their clothing which in itself was not burned.

It is interesting to note that all the helmet work was done with apparatus kept at the mines, by men drilled for that work by the company. The company rescue car was at the mines shortly after 2 o'clock and helped the local corps in their work. All the bodies, with the exception of the two firebosses, Farley and Fessler, who were caught under the cave, were out of the mine by 5 o'clock that afternoon.

As is usual in such occurrences, acts of great heroism and self-sacrifice were displayed by mine officials, state mine inspectors, and mine workers. The accident having occurred in Inspector Price's district, he was the first of the state force to reach the mine, and among the first of the second rescue party to enter. He took charge of the work of the rescue corps, and directed the removal of the bodies and the search for the injured. It was he, in company with Charles Fegley, a miner, who discovered District Superintendent Lorenz, fatally injured, with the clothing torn off the lower part of his body, crawling along the gangway. He immediately sent for aid to carry the injured superintendent to the surface, disrobed himself and put his clothing on the injured man, and then when not ministering to him, walked up and down the gangway to keep himself warm. From the time he arrived at the mine he remained there until 5 o'clock the following Saturday evening, returning the next morning and remaining until Wednesday night, when through illness due to overexertion and loss of sleep, he was compelled to go home, where he was confined to his bed until 3 o'clock Friday morning. Then, on receiving word that Fireboss Farley's body had been found, he returned to the mine.

State Mine Inspectors Curran and Brennan of the 18th and 19th districts arrived on the scene on the evening of the disaster and Inspectors Lamb and Fenton of the 12th and 13th districts arrived the next morning. The inspectors, with Division Superintendents Kaercher and Brennan, and District Superintendent McDonald of the company's force, were, as was to be expected of such men, constantly on the job and leaders in the arduous and dangerous work.

Charles Enzian, mining engineer of the United States Bureau of Mines, was in the western part of the state at the time of the explosion and arrived on the scene Sunday evening, and along with the officials and state mine inspectors made an examination of the condition of the mine.

W. J. Richards, vice-president and general manager of the company, was at the mine daily and until late at night doing all that was possible in directing the work of recovering the bodies of the two firebosses, and the safety of the men at work.

Neither time nor expense will be spared by the company or the State Department of Mines to determine the cause of the accident, so that a recurrence of such a disaster may be prevented at any of the company's operations, or those of any other mining company.

In commenting on the service rendered by subordinate officials and mine workers, Inspector Price said: "Dan Morgan is the true hero." It was Morgan that led a party of three men, who entered the mine immediately following the second explosion and got out the three men near the tunnel who were still alive.

The victims were: John Lorenz, inside district superintendent; John Farrel, foreman; John Fessler, fire boss; Daniel Farley, fireboss; *Daniel McGinley, fireboss; *Henry Murphy, fireboss; *Thomas Behney, miner; *Harry Schoffstall, night inspector; *Jacob Koppenhaver, bottom man; *Harry Hand, driver; *Howard Hand, driver; *Victor Zanin, blacksmith; *Egioli Luchi, blacksmith helper; Alex Lishmut, repairman; Carmine Decompey, chargeman; Richard Fedring, laborer; Anthony Oposcich, laborer; Mike Depauli, laborer; Mike Defaldape, laborer; Joseph Groziono, laborer.

The inquest on the death of the 18 men first found was held August 12, 18, and 19, at Tower City, Pa.

The verdict rendered by the coroner's jury is as follows: "After hearing the evidence, we find that the 18 men came to their death from the result of an explosion of gas, in Fire Boss Daniel Farley's district, but from the evidence submitted to the Jury we fail to find the cause showing contributory negligence on the part of any one."

* First rescuing party.

Care and Lubrication of Air Compressors*

Having noticed in the Alabama Supreme *Court Reporter* a decision, awarding heavy damages to the administrators of a man killed in the mines by gas from the exhaust of a compressed-air driven pump, when he went to start up the pump, the Secretary takes the liberty of giving you the following information, gathered from reliable sources, in regard to the care and operation of air compressors, with respect to safety and efficiency, viz.:

It is a fact that air compressors frequently pollute the mine air with dangerous gases, and sometimes explode, causing damage to persons and property. In either case the same may be generally attributed to the excessive heating, in the presence of compressed air, of the oil and foreign substances that have collected in the cylinder, discharge pipes, and air passages, and especially in and around the valves. Volatilization and ignition of oil and other carbonaceous matter occurs very rapidly in the presence of highly heated air.

The greatest heating takes place where the air passes from the cylinder into the discharge pipe.

Even though the compressor is equipped with modern and approved cooling devices, insufficiency of size or too many angles in the discharge pipe, or incrustation of dust mixed with oil at the discharge opening decreasing the capacity of the discharge, any or all of them, may produce enough heat to cause an explosion, or anyway, produce dangerous gases, which should not enter the mine.

It is therefore, important:

First.—To keep the compressed air, while being compressed, at as low a temperature as possible.

Second.—To prevent oil and other carbonaceous substances from collecting in any part of the machine or in the discharge pipes.

All ports and air passages should be as large as practicable and should be kept free from obstructions and incrustations. In addition to partly closing the ports, incrustation often causes the valves to stick resulting in disastrous consequences. When the valves stick it causes a "back kick" and considerable friction in recompression, which produces great heat.*

To avoid incrustation and collecting of oil and foreign substances in the machine and discharge pipes, high-grade non-carbonizing oil may be used and should be properly fed into the cylinder. Petroleum oil, especially free from volatile carbon, with flash point of not less than 625° F. is recommended.† The oil should not be too dense, nor contain animal or vegetable oil. Do not in any case, use ordinary steam cylinder oil. Why? Because the heat in the steam cylinder is moist, and the surplus oil is washed out, whereas the heat in the compressor cylinder is dry, thus causing the oil to stick and cake. For the above reason, and also on account of the difference in the character of the proper lubricant and the work it has to perform, the proper feeding of oil, to the compressor cylinder, is very different from the oil feed to a steam cylinder. Too much oil causes incrustation. A surprisingly small quantity of good oil will give sufficient lubrication to air compressors. Watch your compressor and cut the amount of oil down to the minimum of its requirements. Oil should not be allowed to collect in the machine. In case it does, it should not be allowed to remain, but should be drawn off immediately.

Even when using the best oil, properly fed to the cylinder, the machine should be cleaned frequently or when needed.

Do not use kerosene for cleaning. It is very dangerous. Kerosene has a flash point of about 120° F. and the temperature of the compressed air may at any time reach 300° to 450° F. and cause an explosion. The best and safest method of cleaning is to feed into the air cylinder, soapsuds, made of 1 part of soap to 15 parts clean water. Feed a liberal amount of this solution into the cylinder instead of the oil for a few hours or even for a day, if necessary. The accumulation of this water and oil should be drained off from time to time during the process by opening the blow-off valve at the receiver.

To prevent rusting, it is necessary to run the machine and feed oil into the cylinder for an hour or so after the cleaning process is completed and the water drained off, so that the valves and all parts connected with the cylinder will become coated with oil before shutting down the machine.

The temperature of the discharged air should never exceed 250° F. The machine should be watched and if the temperature exceeds the above, it should be shut down and cooled.‡ The cause of overheating should be eliminated before starting up again.

The temperature increases as the pressure increases, therefore, it would be well to equip all air compressors with an automatic pressure or temperature regulator, which will allow the compressor to run idle as soon as the pressure or temperature in the receiver reaches a predetermined limit, and likewise bring the compressor into action as soon as the pressure or temperature falls below this limit. There are regulators on the market which apply to compressors coupled direct to the engine, or driven by electric motors, or driven by belt and pulley.

As an extra precaution, a fusible plug may be placed in the discharge pipe near the compressor. This plug should be constituted to fuse and blow out at a temperature of between 325 and 350° F.§

Remember that proper construction, proper care of the machine, and high-grade lubricants, may save life and are cheaper than shut-downs, lost power, destruction of property, and damage suits.

*Safety Pamphlet No. 2, prepared by James L. Davidson, Secretary, under the approval and direction of the Mine Casualty and Mining Institute Committee of the Alabama Coal Operators' Association.

*It is claimed that the Rogler-Hoebiger valve practically eliminates the backflow and works without lubrication. It may, however, be impracticable to apply to machines already installed and to certain kinds and sizes of machines.

†Flake graphite mixed with the oil and fed into the machine has been found to be a very satisfactory and safe lubricant. Also a mixture of castile soap and clean water may be used provided the within-named precautions are taken to prevent rusting while the machine is shut down.

‡The machine may be equipped with a recording thermometer, especially designed to continuously record on a chart the temperature of the air where it passes from the compressor into the pipe line. A suitable thermometer for the purpose is manufactured by The Bristol Company, Waterbury, Conn.

§Fusible plugs are patented but may be obtained from hardware supply houses or dealers in mining machinery and supplies.

Notes on Mines and Mining

Reports on Conditions and Other Matters of Interest in Various Coal Fields

By Special Correspondents

CALIFORNIA.—*Panama International Exposition.* In view of the fact that the mining industry has contributed more than forty billion dollars to the wealth of the United States during the last quarter of a century, it is not surprising that it is planned to make an impressive display of this industry at the Panama-Pacific International Exposition, to be held in San Francisco in 1915.

Charles E. van Barneveld, Chief of the Exposition's Department of Mines and Metallurgy, is making every effort to gather under the roof of the great building that will house the mining and metallurgic display a collection of object lessons that will show the mineral resources of every country and the methods of extracting them from the earth. The display will be a liberal education in the science of mining.

The manufacturer of mining machinery will share in this expansion in proportion to his enterprise. The far-sighted man will see in this exposition an opportunity that will never recur.

ILLINOIS

The Illinois Mine Fire Fighting and Rescue Station Commission has promulgated a set of rules to be observed in case of mine fires and explosions. The rules are published in booklet form and classify the duties of every one concerned in five classes: (1) The duties of the rescue-station superintendent are first outlined, and he is expected to find out the nature of the disaster, get rescue equipment to the scene, and organize a system of working. (2) The duties of the rescue-station assistant require him to assume entire responsibility for the condition of the rescue equipment and to keep constant communication with the rescuing corps inside in order to forward supplies. (3) The duties of the Springfield office are to render promptly any assistance required and to have other rescue cars ready if needed. (4) The duties of the advance squad are to thoroughly test the apparatus by sitting down a few minutes before trying to work with it, follow the leader, keep together, chalk the way in and out of the mine, and make careful examinations for gas, fire, or other dangers. (5) The duties of the mine management require a competent man in charge, who must cut out all electric currents entering the same, examine all safety lamps used, keep a record of the men entering and leaving the mine, and hold in readiness repair gangs, physicians, etc.

The roof of the mine should be carefully examined by the helmet men before fighting fires. Water from a hose should not be thrown on the roof as it may affect the roof. A row of props, well set, will reduce this danger considerably.

The Dering Coal Co., of Westville, Ill., in its annual report of mine accidents and fatalities for the year ending June 30, shows that in that time there was not a single fatality in its three mines. Out of over 1,000 men employed only eight received injuries which kept them from their work. The report praises the men for their cooperation in the prevention of accidents.

Illinois Mining Institute.—At the Fuel Conference in Urbana, Ill., in June, the following were appointed a committee to organize the Illinois Mining Institute: Mr. J. D. Peters, Chicago-Carterville Coal Co., Carbondale, Ill.; Mr. Allard, of the Bunsen Coal Co., Westville, Ill.; Prof. H. H. Stoek, University of Illinois, Urbana, Ill.; Jos. Pope, President U. M. W. of A., Springfield, Ill.; and Martin Bolt, Chief Clerk, State Mining Board, Springfield, Ill. At a meeting held in Springfield, at which mining men from all parts of the state assembled, an organization was agreed upon and a constitution was adopted. The next meeting will be held in November at a time and place designated by the executive board. The following officers were elected: President, John P. Reese, general superintendent Superior Coal Co., Gillespie, Ill.; first vice-president, Andrew Flesher, superintendent, Taylorville, Ill.; second vice-president, Robt. Eddie, subdistrict president U. M. W. of A., Cantrall, Ill.; secretary-treasurer, Martin Bolt, chief clerk, State Mining Board, Springfield, Ill.; executive board, A. J. Moorshead, Madison Coal Corporation, St. Louis, Mo.; Gorden Buchanan, Chicago, Ill.; Harry Fishwick, miner, Springfield, Ill.; Thos. Moses, superintendent Bunsen Coal Co., Westville, Ill.; Prof. H. H. Stoek, Professor of Mining Engineering, University of Illinois, Urbana, Ill.

Chief Clerk Martin Bolt, of the Illinois State Mining Board, says: The New Staunton Coal Co.'s mine, at Livingston, Ill., has from October, 1904, to June 30, 1913, produced 4,531,844 tons of coal. In June, 1913, this mine worked 9 days and averaged 4,110 tons per day. From July 1, 1912, to June 30, 1913, working 213 days, the output was 848,721 tons, making the average hoisted per day 3,986 tons. Had the engine not suffered a breakdown in February, Mr. Bolt thinks the mine would have averaged 4,000 tons per day; as it is, he thinks it has made the record output.

During the year ended June 30, 1912, 51 mines in the state of Illinois, produced more than 300,000 tons of coal. From these figures it is evident that the large mines affiliated with railroads and other corporations are getting most of the coal business in the state, and the indications are that soon the small mines will be a thing of the past.

KENTUCKY

There is great activity in opening coal mines along Pond Creek, in Pike County, Ky., at this time. At the mouth of Pond Creek, opposite Williamson, W. Va., Mr. Wm. Leckie is said to be about to open a mine at Leckieville.

About 16 months ago the Pond Creek Coal Co., of which T. B. Davis, of New York City, is president, began opening its Nos. 1 and 2 collieries on Blackberry Fork of Pond Creek, about 5 miles south of Williamson. The company has built the mining town of Hardy, which contains dwellings for nearly one hundred families at that point. Its Nos. 1 and 2 mines are in active operation, with tipples, tracks, electric locomotives, electric mining machines, electrically driven fans, substations for converting alternating into direct current, a temporary Y. M. C. A. building, a store, and everything needed.

At Stone, Ky., about 8 miles south of Williamson, the same company has built a somewhat larger town, and has opened its No. 3 colliery, fully equipped with all those things enumerated for the collieries at Hardy. It has also built one of the handsomest central power houses to be found in any mining district. This structure, of stone, steel, and concrete, is equipped with two alternating-current generators, about 600-kilowatt capacity, 2,300 volts, one direct connected to a steam engine, the other to a steam turbine; one unit being in reserve. The current is stepped up to 11,000 volts, transmitted to the substations, stepped down for outside use, and converted into direct-current 250 volts for mine use. All the modern appliances for heating and condensing are found in this building. In the boiler house, under same roof, there are four 300-horsepower Babcock & Wilcox boilers with underfed Jones stokers. The general operating offices of the Pond Creek Coal Co. are located at Stone, in charge of Messrs. E. P. Merril, assistant to the president, and Fred Myers, general superintendent.

The Tierney Coal Co. is opening a mine on Mullens Fork, just across from Stone.

About 2 miles south of Stone, on Pond Creek, the Pond Creek Coal Co. has opened and equipped Nos. 5 and 6 collieries in the same manner as to dwellings, tipples, and other equipments as the preceding mines, including Y. M. C. A. building.

About a mile and a half still farther south, on Pond Creek, the same company has built the mining town of McVeigh in the most thorough manner, with dwellings and mine structures, and has opened collieries Nos. 7 and 8, which, like the others, are in active operation every working day. Forty- and 60-pound rails are used on main haulways and smaller rails in rooms. Steel ties are used very generally inside and steel cars throughout.

The company owns about 31,000 acres of coal and 5,000 acres of surface. It is still actively engaged in building dwellings, having upwards of 200 men employed on this construction alone, although it can already house 350 families.

It will open other mines from time to time, and build churches, schools, and hospitals. At the present time its mines, if fully manned could produce 4,000 tons daily for market. Like all new regions and most old ones, Pond Creek is short of miners.

The seam worked is probably the Warfield (No. 2 gas) coal and is from 4 to 6 feet thick, with one parting 4 to 7 inches thick located about 3 feet above pavement.

NEW YORK

Large Damage Award.—What is said to be the largest verdict ever given in a personal injury case in the United States Circuit Court, was handed down before Judge Chalfield, in Brooklyn, June 27, when Stanislaus Yensavage, a miner, was awarded $37,500 for injuries sustained while in the employ of the Lehigh Valley Coal Co., at Shenandoah. The accident happened at Packer No. 3.

On June 10, 1911, Yensavage, working as a helper in the company's mines, was carrying percussion caps and his oil lamp ignited one. An explosion followed, causing the loss of both eyes, right arm, and all but the index finger and thumb of his left hand. He was in the hospital 5 months. He sued for $50,000. The jury was out 3 minutes.

OKLAHOMA

Telephone Law.—While the installation of the large quantity of mine telephones will be made primarily as a result of a law, enacted a short time ago by the legislature of Oklahoma, making it compulsory for mine operators to equip their mines with telephones, the installations will undoubtedly be instrumental in increasing the efficiency of mine supervision as well as safeguarding the lives of the workers. They will make it possible for the superintendents to keep in touch with their mine bosses every minute of the working day and in this way tend to produce a better spirit of cooperation in the operating forces. The various mines will each be furnished with sufficient telephone equipment to properly safeguard the lives of the miners at work underground. Telephones will be installed in the shot firers' refuge holes, in entries and shafts. Constant communication with the offices at the surface will be possible, and in this way accidents can be reported promptly and proper aid sent to the danger point at once. The shot firers, whose duty it is to enter the mines after the miners have left and explode the charges which will throw down the coal to be loaded the next day, will report their progress according to a prearranged schedule. Failure to report from any one refuge hole on schedule time will serve as an indication of a possible accident, and immediate steps can then be taken to effect a rescue.

PENNSYLVANIA

Mine Foreman's Certificates Awarded.—The following is a list of successful applicants in the mine foreman examinations in the 6th, 10th, 20th, and 24th Bituminous Inspection Districts of Pennsylvania:

Sixth Bituminous District.—Mine Inspector Thomas D. Williams, who with Messrs. Buckwalter and Foster, composed the examining board, of the 6th District in Johnstown, report as follows:

But one of the 28 aspirants for first-grade foreman certificate, Thomas J. Davis, of Johnstown, was successful.

Three of the 28 candidates who were awarded second-grade certificates were Frank Horton, of Johnstown; Walter Williams, of

South Fork; and E. G. Miles, of Portage.

Eight out of 24 were successful in the examination for fire boss. They were: Michael Murphy, Johnstown; William F. Reap, Johnstown; William E. Collins, Johnstown; T. J. Brennan, Johnstown; John Curran, Johnstown; John W. Slater, Johnstown; John Gage, South Fork; and R. G. Lewis, Dunlo.

Tenth Bituminous District.—Mine Inspector Joseph Williams reports the following as having passed successfully:

First Grade: Charles L. Davies, of Nant-y-Glo.

Second Grade: Frank Nicholson, Gallitzin; David Mort, Lilly; John Harris, Lilly; Edward Leahy, Lilly; Augustine Yingling, Lilly; John Davie, Belsano; W. H. Robins, Coupon; Thomas Kavanaugh, Vintondale; John W. Daly, Vintondale.

Assistant Mine Foreman: Thomas Kavanaugh, Vintondale; James P. Berry, Nettleton.

Fire Boss: George Bateman, Nant-y-Glo; John Anderson, Nettleton; Thomas Buckingham, Vintondale; James P. Berry, Nettleton; Herbert Slater, Nant-y-Glo; J. J. Miller, Vintondale; K. N. Maize, Amsbry; Harry Patterson, South Fork; Thomas McCarthy, South Fork.

Twentieth District.—Mine Inspector Richard Maize, who with Frank Moors, of Boswell, and G. Marshall Gilette, of Acosta, composed the examining board, reports the following as having passed the examinations held in Somerset:

First-Grade Foremen: Martin McGuire, William Letcher, C. G. Nichols, William Palmer, Archibald Roberts, and Thomas Mark, all of Boswell.

Second-Grade Foremen: C. F. Rowe, of Meyersdale; Michael Lobone, of Hooversville; and Ross W. Meyers, of Somerset.

Fire Bosses: John W. Taylor, Boswell; Frank Hoover, O. S. Kreger, and Donald J. Craig, of Acosta; D. J. Holsopple, of Boswell, and Clarence B. Branch, of Meyersdale.

Twenty-Fourth District.—Mine Inspector Nicholas Evans, of Johnstown, gives a report of the following as having passed the examinations:

First-Grade Foremen: John Morgan, Johnstown; David Harvey, Dilltown; James Stephenson, Jerome.

Second-Grade Foremen: D. U. Lehman, Windber; Frank Wentz, Johnstown; Patrick J. Hamil, Jerome; Matthew Sherwin, Jr., Scalp Level; Joseph Hotte, Wehrum; H. C. Good, Windber.

Fire Bosses: Joseph Rocoskey, James Yoder, Gordon Mathias, Samuel Hartland, and John E. Lowery, all of Jerome; W. H. Abrams, Windber; James Moors, Johnstown; and Albert Phillips, of Cairnbrook.

The Berwind-White Coal Mining Co. is opening a new mine at Reitz, Somerset County, about 9 miles from its Windber operations. Work will be rushed to early completion and the coal will be stored until the Pennsylvania Railroad completes a spur to the mine.

Fire has recently been discovered in the abandoned workings of the Solon mine, operated by the Prospect Coal and Coke Co., in the lower Connellsville region. Every effort is being made by the company officials and the state mine inspectors to prevent the spread of the flames.

In the mines of the Berwind-White Coal Mining Co., W. R. Calverley, general superintendent, has installed overcasts and stoppings of reinforced concrete. In the same mines concrete and steel are used extensively for roof supports. Recently a very complete telephone system has been put in use, telephones being located in all important main sections of the mines, so that local and long-distance calls can be made from inside of the mines.

John Lochrie, of Windber, has lately taken a lease on the Calvin coal in the Dunlo district adjoining the operation of the Henrietta Coal Mining Co., and has begun the development of the property. He has lately purchased the Eureka No. 36 mine from the Berwind-White Coal Mining Co., through which he expects to mine 200 acres of coal, which he has held by a purchase for a number of years.

WEST VIRGINIA

Shipments of coal and coke over the Norfolk & Western Railway, one of the principal outlets for West Virginia coal, for the month of June aggregated 21,185,852 net tons, which was an increase of 95,950 tons over June, 1912.

For the first 6 months of 1913, the total was 12,272,094 net tons, an increase of 464,519 tons over the corresponding period of last year. Of the total 9,469,615 tons, or more than three-fourths, went to interior consumers, an increase of 350,796 tons over last year. Of the remainder, 1,903,318 tons was absorbed by the coastwise trade, an increase of 89,020 tons over the first 6 months of last year, while 899,161 tons were for export, an increase of 23,703 tons.

Employes Magazine

The Lehigh Valley Coal Co. in its endeavors to increase the intelligence of its mine workers, and thereby increase their efficiency, has as a supplement to other educational features, such as local night schools, institute work, etc., started the publication of a small quarterly with the title of *Employes Magazine*. The first number, dated July, 1913, has just reached us. It is edited by M. S. Hachita, assisted by P. Wainer. For a first number of a magazine which is the pioneer in its field, it is a very creditable publication, judged both by the contents and the mechanical work on it. Naturally, it is somewhat of an experiment, and its permanency will depend on how it is received, appreciated, and used by the company's employes, among whom it is distributed free.

It is designed that the magazine shall interest all employes, from the mine foreman down to the nippers and door boys, all the mechanics, clerks, and surveyors, and their wives, daughters, and sisters. Naturally, its principal forte will be the discussion of subjects relating to the production and preparation of coal, though some attention is paid to subjects of feminine interest.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not neccessarily for publication.

The editors are not responsible for views expressed by correspondents.

Conveying Sand by Compressed Air

Editor The Colliery Engineer:

Sir:—We wish to convey motor sand by compressed air from boiler house to drift mouth, a distance in one case of 500 feet horizontal, 75 feet vertical; in another case 1,000 feet horizontal, 200 feet vertical, and would like to have the experience of readers who have tried the stunt, telling method of feeding and discharging the sand to and from the pipe. L. Y.

Nova Scotia Examinations

Editor The Colliery Engineer:

Sir:—Will you kindly answer the two following questions given in the Nova Scotia mining examinations.

1. Explain why a pump situated at the bottom of a deep mine can lift water a greater vertical distance than one situated on the surface.

2. What parts of a winding engine foundation should be the heaviest, and give reason why?

Also would you kindly give the distinction between a "double" steam engine and a "duplex" steam engine if there is any. Subscriber

Springhill, N. S.

Shaft Sinking in Wet Ground

Editor The Colliery Engineer:

Sir:—Replying to letter of D. H. J. Stockett, in your July number, requesting information as to the best method to use in connection with wet shafts to exclude water during sinking and minimize pumping after completion of shafts.

The grouting system, using neat cement grouting and forcing the same into the water-bearing strata with compressed air has been found very efficient, practical, and economical. This method has been used for some years in Europe and has lately been used extensively in connection with the New York aqueduct system for both shaft and tunnel work.

So far as known, the first coal-mine shafts in this country to use this method for excluding water during sinking and to avoid excessive pumping after completion of shafts were begun under the supervision of the writer something over a year ago and the process has been used a number of times successfully and repeatedly since that time.

During the progress of this work flows of water, in some instances over 7,000 gallons per minute, have been encountered and successfully shut off and practically eliminated at a reasonable cost by this method. It is also entirely practicable, by the use of this method, to shut off all water before work is begun on the shafts so that all sinking will be done through ground practically dry. This is much the better method and should result in greatly reduced cost for shaft sinking. Wm. B. Crawford,

Consulting Engineer

Bluefield, W. Va.

Test of Safety Lamps

Editor The Colliery Engineer:

Sir:—I saw an interesting test of two safety lamps made by our superintendent the other day which I think will be of interest to the coal-mining fraternity.

The two safety lamps on which the experiment was made were an old Davy lamp which has seen many long years of service and a new Beard-Mackey lamp which has not seen any service and is just as it came from the hands of the manufacturer.

The two lamps were trimmed and lighted, both having about a normal flame. A Baldwin carbide miner's lamp was freshly trimmed and put in good condition for burning. The flame of the Baldwin lamp was then blown out and the jet of carbide gas from it was directed through the gauze of the Davy lamp. The carbide gas burned within the gauze of Davy lamp quietly and without any explosion. The Baldwin lamp was approached close to the gauze of the Davy, but the flame from the burning gas within the gauze of the Davy lamp did not ignite the carbide gas outside of the gauze. The experiment was tried quite a number of times with the same result. The jet of carbide gas was then directed on the perforated ring below the flame of the Beard-Mackey lamp. The carbide gas ignited and exploded with some force and the flame ignited the carbide lamp on the outside of the gauze of the Beard-Mackey lamp. The experiment was tried quite a number of times, nearly every time with the same result.

The gauze of the Beard-Mackey lamp was examined and found to be practically the same as the gauze in the old Davy lamp, but we found that the narrow strip or ring of gauze that protects the $\frac{1}{8}$-inch apertures in the base of the Beard-Mackey lamp and underneath the flame, was a loose ring or strip of gauze and at several points on its upper periphery it did not lie close to that part of the lamp which contained the $\frac{1}{8}$-inch apertures, so that it is possible that the flame from the burning gas did not come through the gauze but escaped between the gauze and the body of the lamp, and in that way lighted the carbide gas outside of the lamp. I have never seen a Beard-Mackey lamp before and do not know whether the failure of our lamp under this test is due to defective construction or if all the lamps of this make are similar to the one we have.

It is evident that this is a very interesting subject for any one who may ever have occasion to use this

kind of lamp and I would be pleased to have any owners of Beard-Mackey lamps submit them to this simple test and advise us of the result.

Miner

[It is probable that the action of the Beard-Mackey lamp was due to damage occurring after leaving the makers, or even to faulty work on it, and not to the principle on which the lamp is constructed. There is nothing in the principle of the Beard-Mackey lamp to cause such action, and the type of lamp should not be condemned on account of faulty construction in one lamp. However, the experiment described by our correspondent emphasizes the necessity of close scrutiny of such lamps so as to assure safety. The suggestion that other owners of Beard-Mackey lamps submit them to the same test and publish results is a good one. Editor.]

Acetylene Lamp Difficulties

Editor The Colliery Engineer:

Sir:—With a great deal of interest I have read your editorial on "Acetylene Lamps in Coal Mines" in the August number, and also the article on the same subject in another part of your paper.

From the view point taken the argument is very good, but unfortunately there is another point of view. I wonder if another manager, superintendent, or mine boss has an experience similiar to this: During their tour of inspection, to discover two day hands sitting by the road side, one working at an acetylene lamp while the other shows him light. Reason? Many of the causes which prevent an acetylene lamp from burning. Time wasted, about ½ hour for each man, company's loss, about 40 cents on the average occurrence; managers, superintendents, or mine bosses loss, a considerable amount of religion—if they have any.

A short time ago, desiring to inspect a piece of work some distance inside the mine, and the mine boss not being available, I went to the place alone. After satisfying myself as to the work, I decided to return by a short cut through some old workings, forgetting that "the shortest way home is the longest way round." Part way through the old workings my lamp went out. I had a plentiful supply of carbide and water but the burner was stopped. The little piece of wire, soldered to a small piece of tin was missing. I had four matches and managed to get outside, but my faith in the acetylene lamp is badly shaken.

The oil lamp is dirty and gives off a great deal of smoke, especially in mines in this state where the mine laws do not forbid the burning of lubricating and other smoky oils, but it is to be depended upon at all times for its light and smoke.

This point of view may not be a progressive one, but I feel there is yet much to do to the acetylene mine lamp before it becomes a practical success, and I hardly believe that its adaptability to detect blackdamp and other poisonous gases will so favorably overbalance its other annoying features as to warrant it being taken up generally.

I notice a small percentage of my employes use the acetylene lamp, but very few lasting converts are made. The usual reason given for giving up their use is the annoyance and bother in the attention necessary to keep them in operation.

G. M. Shoemaker

St. Charles, Va.

Is Anthracite Dust Explosive?

Editor The Colliery Engineer:

Sir:—In the July issue of The Colliery Engineer I find on page 718, the following statement in answer to Ques. 26: "As the dust of anthracite coal is not explosive." If to this had been added "under ordinary mining conditions," the statement would be fairly satisfactory, but in the form presented I consider it objectionable.

Although the men connected with the different experiment stations have found that under the conditions of the tests there was little or no propagation of flame by anthracite coal dust, they did not conclude on that account that anthractie coal dust is non-explosive, but stated that there may be conditions under which extensive propagation of flame can be obtained. Some years ago Mr. Haas stated, in Mines and Minerals, that although ordinarily anthracite coal dust has shown little or no explosive characteristics, that fact should not be taken as proof that conditions cannot arise that would render it highly explosive, and he further concludes that should these favorable conditions exist and an explosion result, its force could be expected to be very much greater than the force of an explosion caused by bituminous coal dust.

If The Colliery Engineer has the proof that anthracite coal dust cannot be exploded under any conditions it should be presented.

John Verner

Chariton, Iowa

[When writing on the dangers of coal dust and shot firing in 1883, the editor stated: "Shot firing has, in all probability, to answer for more fatal casualties than some are inclined to ascribe to it. These accidents do not happen so much in anthracite mines, from the fact that there is scarcely any dust floating in the air when compared with the bituminous mines; however, we are not sure but that it may apply in some instances even to them."

There were three reasons for this statement: Anthracite does not pulverize to impalpable powder in coal mines, as do certain bituminous coals. It is more difficult to ignite than bituminous coals; and finally it contains so small a quantity of volatile hydrocarbons that the heat of an explosion or blown-out shot cannot produce enough gas from the coal to cause or augment an explosion. As stated many times in these columns, there is more gas given off from the strata in anthracite mines than in bituminous mines as a rule, and there are more explosions in the anthracite mines of Pennsylvania than in the bituminous mines of the same state, yet these are local and do not extend throughout the mines, as the dust fails to ignite.

Mr. Verner wants proof that anthracite dust cannot be exploded

in anthracite mines. There is an old saying the proof of the goodness of a pudding is found when eating, so it is assumed that if a thing has not occurred, and cannot be made to occur it is not likely to occur and why worry about its occurring. It is believed that Mr. Verner knows the conditions that prevail in anthracite mines, but for the benefit of others it is stated that probably not one working day passes without gas being fired in some one of the anthracite mines, yet there are few fatalities and no great disastrous mine explosions. For instance, in the 20th District in 1911, 17 men were burned and one killed by explosions of gas. In another district 11 were burned and none killed, and so on. This small number of fatalities is due to the dust failing to ignite. Out of probably 300 gas explosions taking place yearly in anthracite mines there has been no general explosion throughout a single mine, which is positive proof, in the editor's opinion, that anthracite dust in mines is not explosive. In the last 32 years there have been many thousands of local gas explosions throughout the anthracite fields, yet not one has been extended by dust, although the roads may not have been cleaned in several years.

Owing to anthracite being necessarily shot from the solid there are many blown-out shots. These have frequently set fire to gas (and gas has frequently set fire to shots), yet there is not one case recorded where the shots set fire to dust, even although black powder is generally used.

There have been many explosions of powder in large quantities in anthracite mines, yet these have not caused dust explosions, although noxious gases have been generated in such large quantities as to cause death.

Numerous experimental attempts have been made to explode anthracite dust as it comes from the mine, and also dust that had been pulverized to pass through a 100-mesh sieve, yet they proved abortive.

Mr. Frank Haas, like the editor, when he first wrote on this subject, used a qualifying clause because his experience and observations were not so wide as at present. While the editor did not write the phrase Mr. Verner objects to, he has known of black powder being used almost entirely for mining anthracite, and while the tamping has always been anthracite dust, no dust explosion has occurred in his time and none is recorded since mining began; therefore he feels safe in saying that the dust in anthracite mines is not explosive. Editor.]

OBITUARY

RICHARD NEWSAM

"Uncle Dick" Newsam, the most widely known and universally liked coal man in Illinois, died at his home in Peoria, Ill., August 4, 1913. He was born in Chorley, England, in 1843, came to this country in 1869, and became superintendent of the

Richard Newsam

Lowry mine at Kingston, Peoria County, Ill. In 1874 he and his brother became large coal operators, and so late as May this year he was putting down a shaft.

In 1897 he was appointed a member of the State Mining Board, on which he served as chairman continuously until the fall of 1912, when, on account of ill health, he resigned from this position, and also as the manager of the mine-rescue stations of Illinois, the establishment of which was largely due to his efforts. Mr. Newsam was prominent in the councils of the Illinois Coal Mine Operators' Association, and being a practical miner was considered the best posted coal man in Illinois. His dealings with the mine inspectors under him was such that they thought of him more as a father and friend than a superior. He was a thirty-second degree Mason and Shriner. Mr. Newsam was a history maker in the state of Illinois.

The following resolutions were passed by the State Mining Board and State Inspectors of Mines:

Whereas, It has pleased an All-wise Creator to remove from our midst Richard Newsam, who for a number of years was the president of the State Mining Board, and

Whereas, By his ability and honesty, the standard and efficiency of the State Mining Board and State Mine Inspection Service has been raised until we are second to no similar board in the United States of America, and

Whereas, The deceased, by his wide knowledge of mining matters, practical and theoretical, and his aptness and ability in imparting such knowledge to all who were seeking the same, was a valued and competent presiding officer of the State Mining Board; therefore

Resolved, That we pay a just and fitting tribute to his ability and memory when we mourn for him as one in every way worthy of our respect and esteem.

Resolved, That we sincerely condole with the widow and family of the deceased, and commend them to the keeping of Him who looks with tenderness on the widow and fatherless.

Resolved, That these resolutions be spread on the records of the State Mining Board, and that copies of the same be forwarded to the widow of our friend, to the newspapers and mining journals of the state, and that the same be made a part of the Thirty-Second Annual Coal Report.

State Mining Board: Evan D.

John, acting president; Martin H. Linskey, hoisting engineer; S. M. Duggan, secretary; Wm. Spenny, member; Martin Bolt, chief clerk.

State Inspectors of Mines: Hector McAllister, 1st district; Thomas Hudson, 2d district; John Dunlop, 3d district; James Taylor, 4th district; W. S. Burris, 5th district; Thomas P. Back, 6th district; W. W. Williams, 7th district; W. L. Morgan, 8th district; Walton Rutledge, 9th district; Thomas Little, 10th district; Frank Rosbottom, 11th district; J. W. Fairbairn, 12th district.

GEORGE HARRISON

By the death of George Harrison, one point in the base line of the coal-mining industry in Ohio is lost. Arriving in this country in 1880, he became superintendent of the Wainwright mine, at Byesville, Ohio. He was active in formulating the Ohio state coal mine laws and became an active worker in the United Mine Workers of America, not, however, using that society as a means of livelihood, but to advance those ideas which he believed were for the best interests of the mine workers in Ohio, as the operators fought state mine legislation vigorously. He was appointed State Mine Inspector in 1904 and held the office until August, 1912, when he was superseded by Mr. J. C. Davies. George Harrison was so thoroughly respected by the coal mine inspectors of the various states he was made the first president of their society and served in that capacity 3 years. Mr. Harrison was born at Greenhead, England, in March, 1846, and died from a stroke of paralysis at Caldwell, Ohio, July, 1913.

H. A. NELSON

H. A. Nelson, for 30 years connected with the Pleasant Valley Coal Co., Utah Fuel Co., and Wasatch Stove Co., died at his home in Salt Lake City on July 18, 1913, aged 53 years.

The state of Virginia mined 7,846,638 short tons of coal in 1912 valued at $7,518,576, an increase of nearly 1,000,000 tons over the 1911 production.

Advances in Permissible Explosives*

The degree of safety which is demanded of safety explosives at present, and which has already been reached, has been formulated in Germany purely from a practical standpoint and from experience, as follows:

A maximum charge of 700 grams which does not ignite coal dust and gas is accepted, while explosives which in quantities of 250 grams ignite dust are not recognized as permissible, even if the comparative potential energy should be in their favor.

Naturally explosives which even in large charges are safe are considered to develop less force.

In German explosive factories, there is a tendency to increase the safety point of ignition by the addition of certain salts (especially sodium chloride); this is, however, more the case for coal dust than for firedamp ignitions.

This admixture has two serious drawbacks: the force of the explosion is weakened, and the hygroscopicity is increased. The latter particularly is of grave import; for even if durability is less requisite for civil than for military purposes, it is nevertheless, extremely desirable.

One might, of course, where other great advantages exist, such as great degree of safety and cheapness, prefer a less durable to a more permanent explosive, and by shortening storage, regular replenishing of supply, and rapid consumption, attempt to equalize the fault of rapid deterioration. However, this procedure has its limitations, and as a rule a more stable compound is always to be preferred. The deterioration of the strength from dampness or chemical and physical changes, has, as a result a number of disagreeable consequences, such as failure to explode, boiling out of the charge, increased cost of blasting work from loss through spoiled, worthless remnants which could not be used.

Good ammonium-nitrate explosives can be prepared which, in the usual paraffined packing, will remain unchanged for several years, which is all that is required in practice. This is due to their composition. It can even be maintained that, good ammonium-nitrate explosives, in spite of their hygroscopicity, are more durable than dynamite, which loses considerable of its force and strength after having been frozen and thawed repeatedly.

Another important point which affects all explosives used in mines, and consequently also the permissible safety explosives, is the character of the explosion gases. In this respect ammonium-nitrate explosives of correct composition undoubtedly occupy the first place. The disagreeable feature of black blasting-powder smoke and the poisonous qualities of the dynamite fumes, are too well known to require any detailed discussion. The compounds of the carbonite class (carbonite, monobel, and others), also give rise to toxic gases in consequence of the nitroglycerine and other admixtures; the most recent chlorate compounds are still worse in this respect. But explosives of the ammonium-nitrate class can, under certain conditions, also give off noxious gases; as was shown to be the case with roburite, on account of its nitrobenzol content, and those ammonium-nitrate compounds, which on account of their dosage do not permit a complete conversion of its ammonium-nitrate, and consequently generate nitrous gases. These nitrous gases are particularly treacherous; their action is not immediate and transitory like the dynamite gases, but far-reaching and frequently manifest only at a later period. In Austria there have also been complaints of this nature, and fatal affections are said to have resulted.

Ammonium-nitrate explosives can be manufactured which give scarcely any smoke and only innocuous gases. This is of inestimable value, since not only the health of the laborer is preserved but there is also a saving of time, since they can return immediately to their working place after the charge of the shot has exploded.

*Translated by W. H. Blumenstein, Pottsville, Pa. from "Zeitschrift Fuer Das Gesamte Schiess-Und Sprengstoffwesen, etc." Munich.

Practical Talks on Coal Mining

For men who desire information on Coal Mining and related subjects presented in a simple manner

Mine Ventilation

Mine Doors—The Purpose for Which They are Used, Methods of Construction, and the Requirements of the Mine Law Regarding Them

Written for The Colliery Engineer (*Continued from August*)

NOTE—Owing to an oversight a footnote to the article "Mine Ventilation" in the August number was omitted. This would have called attention to the fact that Fig. 1 was an ideal and not an actual method of mining. Naturally rooms are not turned and driven beyond the last breakthrough as therein shown.—Author.]

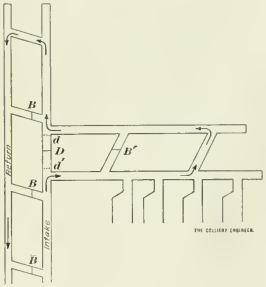
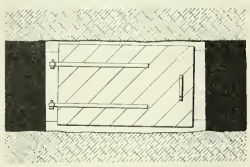


Fig. 2

In order to deflect the air from one entry to another, as from the main intake into a side, cross, or butt entry, an obstruction must be placed across the former, as shown at *D* in Fig. 2. In event of the main intake being used as an airway only, that is, if no hauling or traveling is done upon it, the obstruction may be permanent in its nature and is called a brattice or stopping. However, in all mines opened upon the double-entry system, the main intake is also the main haulage road so that some arrangement must be made whereby men and trips of cars may be able to pass any device used to change the direction of the air-current. To do this a door, such as shown at (*a*) and (*b*) in Fig. 3, is commonly provided unless the more modern and far better arrangement of overcasts is used. In rare cases these doors are made entirely of sheet iron; sometimes a thickness of boiler plate, sometimes hollow and of thinner material. While absolutely fireproof they are difficult of repair if damaged by a runaway trip. They are also objectionable in mines where the roof is settling and the shape and size of the entry changing because of the difficulty of altering their dimensions. It is not uncommon to find wooden doors covered with a layer of sheet iron on each side. In this case the metal is very thin and easily cut and adds to the fireproof qualities of the door.



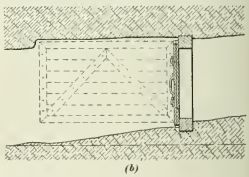


Fig. 3. Forms of Mine Doors

Most doors are made of a double layer of 1-inch plank with occasionally a layer of brattice cloth between them to reduce the leakage of air. The planking is commonly nailed together diagonally, that on one side pitching in an opposite direction from that on the other. This is done to add to the stiffness of the door and to prevent its sagging in the frame. For very wide doors some form of bracing must usually be adopted to prevent settling. In Fig. 3 (*b*) this is accomplished by making a boxing of $1'' \times 6''$ or $1\frac{1}{2}'' \times 6''$ plank entirely around the door with a hipped truss of the same size of material. A similar boxing and truss is placed on the other side of the door and the whole bolted together through the door planking. In place of a single very heavy door for a wide opening, double doors hinged at the sides and meeting in the center are sometimes used. These are much more easily handled than the single door and if struck by a runaway trip are not so apt to be damaged, as they fly open upon the impact of the car.

The width of the door opening is usually not more than enough to give from 3 inches to 6 inches clearance on each side of the car. The height is made sufficient to give say 6 inches headroom above the highest topping on a loaded car. In very wide en-

tries, much used as traveling ways, it is customary to have, in addition to the door opened for the passage of trips, an additional door of small size through which men alone may pass.

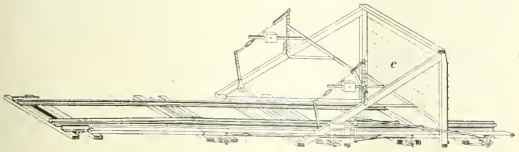


Fig. 4. Automatic Curtain Door

This allows the air-current to be deranged only when a trip is passing, and is a decided advantage.

Doors are usually set in a framing of heavy timber, up to 12 in. × 12 in. for the side posts, and these must be most securely wedged and fastened in place. This is sometimes accomplished by drilling holes in the coal and fastening the posts (or the one to which the hinges are attached) thereto by means of heavy round iron pins. The door at the top and bottom closes upon top and bottom sills, respectively. The upper one should be heavy enough to resist the pressure of the roof and is commonly of the dimensions of the side posts. The bottom sill is lighter, and in haulage entries has openings cut for the rails. A strip of brattice cloth from 4 to 6 inches wide, which projects about one-half these widths, is usually nailed around the four edges of the door to prevent leakage of air. It should be noted that before the door or its frame are set the sides, roof, and floor of the entry should be dressed with a pick so that the framing may be securely and tightly placed and that the door may open freely.

It is required by the legislation of most states (and should be done regardless of any law) that all doors be hung so that they open against the air. This is required because the force of the current serves to keep them shut, as well as to close them if opened but for a short distance as when a man passes through. To prevent the door standing open, it is given a slight fall. This may be accomplished by giving the door frame a slight pitch in a direction opposite to that of the motion of the air so that the door does not hang quite vertical, or may be done by setting the staple of the lower hinge about $1\frac{1}{2}$ inches further back in the framing from the door than the upper one. If the seam pitches it will be necessary to cut both the roof and the floor to give the proper clearance for the door when open, as shown in Fig. 3 (*b*).

The laws of some states require that an extra door, known as safety door, be hung near a main door (a door on the main entry, as *D*, Fig. 2), and always be kept open, but so arranged that in event of any accident to the main door, it can be immediately closed.

It is customary, and is often required by the mine laws, to have doors on the main intake (*D*, in Fig. 2) built in pairs, separated by a certain distance, so that when one is opened for the passage of a trip the other is closed. Such a pair of doors are shown by the dotted lines *d* and *d'*, in Fig. 2. When a trip comes out the entry, the door *d* is first opened for its passage. When the trip is in the part of the entry between the doors, *d* is closed and *d'* opened so that it may pass through, and is closed as soon as cars have passed beyond it. It is apparent that the distance between the doors *d* and *d'* is regulated by the length of the trip which must pass through and is much greater for a three- or four-car trip than for a single car. It is also influenced by the grade of the road, being greater on a pitch than on a flat, owing to the inability of the driver to stop the trip in a short distance when moving at a high rate of speed down hill. The idea of the double doors is to prevent what is called a "short-circuit" of the air, as would be the case if a single door, such as *D*, were left open. It is apparent if *D* is open that no air will pass up the butt entry, but all will continue out the main intake, as this is the shortest course to the fan. If the mine is gaseous, the danger of cutting off the air supply, even for a short time, must be apparent.

The laws of most states require that some one be in constant attendance to open and close doors for the passing of men and trips. These attendants, known as trappers, are usually either boys or very old men, and their wages of from 75 cents to $1.50 (and even more) per day add materially to the cost of production. Assuming that the average mine is in operation 240 days of the year, the wages for a single trapper will amount to from $180 to $360. Should there be 10 doors in the mine, each with an attendant, the annual wages would be from $1,800 to $3,600, and possibly more. Aside from the wages cost, a great trouble with trappers is that, being boys, they will play, and their frequent absences from their doors are the cause of many accidents to themselves and drivers, together with delays and interruptions in the regularity of the haulage. To overcome these troubles automatic or self-acting doors are now very largely

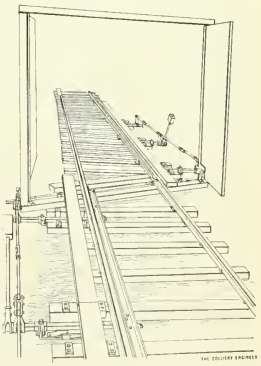


Fig. 5. Automatic Mine Door

used, particularly in the Central coal field. Where the subject is mentioned at all, the law generally requires that an automatic door must be of a type to meet the approval of the state or district mine inspector. These doors do not require attendance other than regular inspection to see that the working parts are clean and are properly oiled.

These doors commonly operate through the pressure of the wheels of the first car of a trip upon a hinged rail or treadle. This rail, being pressed down, its motion is communicated by a series of rods and levers to the door, which is opened and held so until the last car of the trip (after having passed the door) passes off a similar rail, when a system of counterweights causes the doors to close. These doors are of two general types. In the form shown in Fig. 4, the door is more properly a curtain *c* of canvas which is automatically raised (in a vertical plane) to the roof at the approach of a trip, and drops back into place after it has passed. The form shown in Fig. 5 is the more common type and consists of a pair of doors hinged at the sides and opening from the center, but in opposite directions. That is, one opens with and the other against the air, the resistance of which is thus balanced. It should be noted that the doors and all connections are of steel and if set in masonry or concrete frames, as is the best practice, there is nothing inflammable about them. Both the forms shown are arranged so that men may pass through without effort, the door closing automatically behind them.

It is to be noted that there is very little legislation on the subject of the construction of mine doors, so that they are often, and legally, merely a light wooden framework covered with brattice cloth. Such light and usually leaky doors answer well enough for temporary purposes, as when placed between a butt heading and its air-course, but are entirely unsuited for main-haulage roads. Many state laws make no reference to doors at all, but when mentioned it is usually provided that they open against the air. Some few states provide for the employment of trappers or door tenders at main doors, and Ohio requires them even where automatic doors are employed to the extent of seeing that the same close properly. In a few states refuge holes must be provided for the door tenders.

The only state recognizing the general undesirability of doors is West Virginia, the statutes of which provide that "doors on main haulways shall be avoided in gaseous mines where practicable, and overcasts built of masonry or other incombustible material and of ample strength shall be adopted, etc."

(To be Continued)

Mechanics of Mining

An Explanation of the Principles Underlying Calculations Relating to Engines, Pumps, and Other Machinery

By R. T. Strohm, M. E. *(Continued from August)*

THE subject of friction has often been mentioned in the preceding articles and it will be referred to frequently in those that are to follow. It is necessary, therefore, to take some notice of it, to find out what it is, what causes it, and to observe its effects.

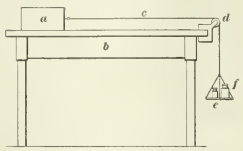


FIG. 31

Friction is simply the resistance that one body offers to the motion of another that is in contact with it. To illustrate, take the case of the cast-iron block *a*, Fig. 31, lying on the top of an oak table *b*. Suppose that a cord *c* is attached to the block, carried over the pulley *d*, and has attached to it a flat plate *e* on which weights may be placed. If the top of the table and the under surface of the block are dry and fairly smooth, and the block weighs 10 pounds, it will be found that weights *f* must be added until there is a total weight of about 5 pounds on the plate *e* before the block will move along the top of the table. This means that the friction of a 10-pound block of cast iron on the surface of an oak table is about 5 pounds.

If there were no such thing as friction, it would require almost no pull at all to cause the block to move across the top of the table. The fact that a force of about 5 pounds is required is because of the frictional resistance, which is due to the relative roughness of the block and the table. It is well known that the smoother the surfaces are made, the more easily will the block be moved; but no matter how smooth the iron and the wood may be made, it will require a pull of about 5 pounds to move a weight of 10 pounds, if both surfaces are dry.

It is not possible to produce a perfectly smooth surface, or a surface that does not have any irregularities. A flat piece of metal may be machined and then scraped or polished until its surface looks absolutely true and smooth to the eye; but if that surface is examined under a magnifying glass, it will be seen to be full of little ridges and hollows. On a roughly machined piece, these ridges and hollows may be seen with the naked eye; but as the scraping or polishing goes on, the ridges become smaller and the hollows become shallower. Yet no matter to what point the smoothing operation is carried, there will always be ridges and hollows at the surface of the piece.

Suppose that two smooth iron plates are laid together, face to face, with one on top of the other. As the surface of each has ridges and hollows, it is reasonable to suppose that some of the high points or ridges on one

piece will project into the low places or hollows on the other piece. If the plates could then be examined under a microscope, along the line on which the surfaces meet, they would probably appear to fit together as shown by the enlarged section in Fig. 32; that is, the irregularities will interlock.

Now suppose that the lower piece *a* is held stationary by being bolted to a frame or to a table and that the upper piece *b* is pulled endwise, in the direction of the arrow *c*. The projections on each piece will then catch against those on the other and will tend to prevent the upper piece from being moved across the lower one. If the pull on the upper piece is strong enough, the block *b* will be moved across the block *a* and some of the ridges will be torn loose from the surface of each block. It is the force required to bend over or break off these little interlocking projections that gives rise to the resisting force, or frictional resistance as it is called.

The friction produced when one body slides on another is called "sliding" friction, and it varies according to certain well-known laws. Some of these laws may be stated as follows:

1. The frictional resistance depends on the perpendicular pressure of one body on the other and does not depend on the amount of rubbing surface.

2. The friction depends on the kinds of materials that are rubbed together.

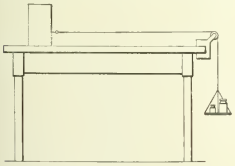


Fig. 33

3. The friction of rest is usually greater than the friction of motion.

4. The friction increases with the roughness of the surfaces in contact and is therefore decreased by smoothing or lubricating them.

The meaning of each of these laws may be made clear by the following illustrations:

Refer again to Fig. 31. Suppose that, instead of a block *a* weighing 10 pounds, it is made twice as high, so as to weigh 20 pounds. Then it will press against the table with twice as great a pressure, and the friction

Fig. 32

will be twice as great, according to the first law given above; that is, a weight of about 10 pounds will have to be added at *e* in order to move the increased weight.

The latter part of the first law states that the amount of surface has no effect on the friction. If the block shown in Fig. 31 were stood up on end, as in Fig. 33, it would still press down on the table with a force of 10 pounds, but the amount of rubbing surface on the block would be smaller, because the end is smaller than the bottom. In spite of this, however, a weight of about 5 pounds would still be required at the lower end of the cord to move the block along the table. In other words, the friction remains the same, no matter whether the amount of rubbing surface is changed.

This law is true, however, only so long as the block does not cut into the table. If the lower end of the block were made so small that the weight would cause the end to dig

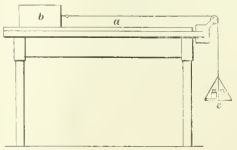


Fig. 34

into the table, then the friction would be very much greater. But so long as there is no cutting of the table top, the frictional resistance depends only on the pressure and not on the area of the surface of the block.

The second law states that the friction depends on the materials of which the rubbing bodies are made. It has already been shown that if a 10-pound cast-iron block is drawn across an oak surface, the friction is 5 pounds. Suppose that a dry, smooth, clean cast-iron plate is fastened to the top of a table, as shown at *a*, Fig. 34, and that the same 10-pound cast-iron block *b* is placed on it. Then the weight required at *c* to move the block will be about $1\frac{1}{2}$ pounds. This means that the friction of cast iron on cast iron is only about one-fourth that of cast iron on oak.

If the plate *a*, Fig. 34, were made of wrought iron, a weight of about $1\frac{3}{4}$ pounds would be required at *c* to cause the block *b* to move. If the plate were made of bronze, a weight of about 2 pounds would be required at *c*. These experiments show that the frictional resistance changes when the materials are changed.

The third law states that the friction of rest is greater than the friction of motion. This means that if the block on the table in Fig. 31 is at rest, a greater pull will be required to start it than to keep it moving after it has once been started. Thus, suppose that a spring balance *a* is fastened to the block, as in Fig. 35, and that the cord *b* is fastened to the balance and pulled steadily in the direction of the arrow *c*. The balance will show a pull of more than 6 pounds before the block will move; but when it has been started, a continued pull of 5 pounds will keep it in motion.

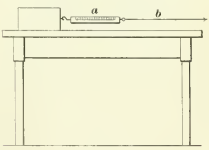


Fig. 35

The fourth law states that the friction is reduced by making the rubbing surfaces smoother or by using some kind of lubricant between them. The reason for the decrease of friction when the surfaces are smoothed has already been explained. It is equally easy to show how the use of a lubricant tends to lessen the fric-

tion. Suppose that the surfaces of the pieces shown in Fig. 32 are lubricated with oil. The oil then fills all the little hollows in each surface and lies in a thin layer on each. When the two surfaces are brought together, the oil forms a thin layer between them, and the surfaces are held apart a very minute distance by the layer of oil. As a consequence, the greater number of ridges are covered up by the oil and are kept from catching on the ridges of the opposite surface. Only the longest of these projections are thus able to extend through the oil film and engage with those on the other surface. As fewer of the ridges come in contact, there are fewer to be bent over or broken off, and as a result the frictional resistance is less.

Other materials than oil may be used as lubricants, as, for example, grease, graphite, soap, and water. But in every case the action is the same; that is, the lubricant forms a thin layer between the rubbing surfaces and prevents them from coming in such close contact as would be the case if no lubricant were used.

Some of the lubricant moves along with the moving piece and some remains on the stationary piece; so it follows that the small particles of the lubricant must slide over one another, and therefore that there must be friction due to this sliding. The thinner the oil, the more easily will the particles slide over each other, and the smaller will be their friction. This being the case, it would seem that as thin a lubricant as possible should always be chosen, so as to reduce the fluid friction; but this cannot always be done.

For example, take the case of the bearings of a head-sheave. If they were lubricated with a very thin oil, the heavy pressure due to the load being hoisted would at once squeeze the oil out from between the rubbing surfaces and the lubricant would be lost. It is necessary, therefore, to use a lubricant that will hold together better and will not be squeezed out; that is, a thicker, heavier oil or a grease must be used.

The benefit to be gained by the use of a suitable lubricant is very great. In the case of the dry block shown in Fig. 31, a pull of 5 pounds was required; but if the rubbing surfaces were made slightly oily or greasy, a pull of about 2 pounds would be sufficient. Thus, the use of a lubricant in this case reduces the moving force by more than one-half.

(To be Continued)

Electricity in Mines

Methods of Grouping Cells—Relation Between Electromotive Force, Resistance, and Current

By H. S. Webb, M. S. *(Continued from August)*

THERE are two common methods of connecting or grouping the cells in a battery: in series, and in parallel, or multiple.

Cells in Series.—Cells are connected in series when the positive terminal $+C$ of the first cell *1* in Fig. 12 is connected to the negative terminal $-Z$ of the second cell *2*, and the positive terminal $+C$ of the second cell *2* is connected to the negative terminal $-Z$ of the third cell *3* and so on as shown in the figure. R represents any conductor connected from the positive terminal $+C$ of the cell *4* at one end of the series set to the negative terminal $-Z$ of the cell *1* at the other extreme end of the series set. This method of grouping cells is the most common and is used when there are available a number of cells, and a higher potential than that of one cell is desired, as in long telegraph circuits and in many bell and other

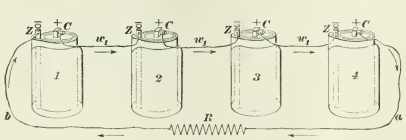


Fig. 12

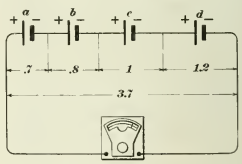


Fig. 13

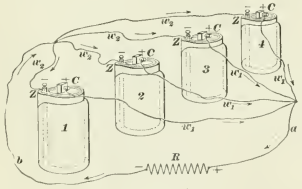


Fig. 14

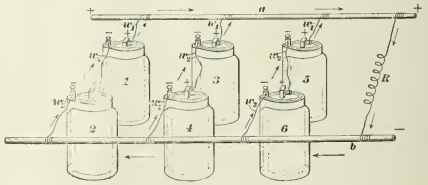


Fig. 15

signaling circuits. Any number of cells from two up may be connected in series.

It would not be correct to say that cells are connected in series simply because the same current must pass through all, one after another, for this is not true unless the positive terminal of one always connects to the negative terminal of the next cell. If, in joining cells in series, the connections of one or more cells are reversed, the same current will pass through all, one after the other, but the reversed cell, or cells, will act in opposition to those that are not reversed and the current would actually be stronger if the reversed cells were removed, and still stronger if they were properly connected in series.

When cells are connected in series the total electromotive force developed by the battery is equal to the sum of the electromotive forces of all the cells. Thus, in Fig. 13, cells *a*, *b*, *c*, and *d* are in series because the positive terminal of one is joined to the negative terminal of the next one, which means that their electromotive forces act in the same direction. The electromotive forces of the cells are .7 volt, .8 volt, 1 volt, and 1.2 volts, as indicated on the figure, and a voltmeter connected across the remaining free, or outside, terminals will give a reading of .7+.8+1+1.2=3.7 volts for the total electromotive force of the battery.

If all cells develop the same electromotive force, the total electromotive force of the battery is equal to that of one cell multiplied by the number of cells connected in series. The total internal resistance of the whole battery is equal to the sum of the internal resistances of all the cells; if all are alike, it is equal to that of one cell multiplied by the number of cells in series.

Cells in Parallel.—Cells are connected in parallel, or multiple, when the positive terminals, as $+C$ in Fig. 14, of all the cells are connected together and to one end *a* of a conductor *R* and the negative terminals, as $-Z$, of all the cells are connected together and to the other end *b* of the conductor *R*. There may, of course, be a number of conductors and electrical devices connected in the circuit between the ends *a* and *b*. This method of grouping cells is used when the external circuit is a better conductor, that is, has a lower electrical resistance than the internal path through one cell and when more current is desired than one cell will supply to such an external circuit. Only similar cells developing like electromotive forces should be connected in parallel. The electromotive force of a group of similar cells is equal to that of one cell only, but the internal resistance is equal to that of one cell divided by the number of cells in parallel.

Cells are connected in multiple series or parallel series by arranging them in several groups, each group being composed of several cells connected in series, and then connecting all the groups together in parallel, as shown in Fig. 15. This method is only used where a higher potential is desired than a parallel group of single cells will give and where a larger current is desired than a single series set of cells would give.

RELATION BETWEEN ELECTROMOTIVE FORCE, RESISTANCE, AND CURRENT

A law universally applicable to natural phenomena is that the result of an effort is equal to that effort divided by the opposing resistance. For instance, if an elastic material is stretched, the amount of stretch will depend on the ratio of the pull to the elastic resistance of the material; if a heavy block is pushed along the floor, the velocity with which the block moves will depend on the ratio of the force exerted to the frictional resistance opposing the motion; and the general applicability of this law, that the result is equal to the effort divided by the resistance, could be almost indefinitely illustrated.

For the passage of a steady current of electricity in one direction through a circuit, the law is, that the current (result) is equal to the electromotive force (effort) divided by the opposition to the current flow (resistance). In the case of a steady direct current, or so-called continuous current, the opposition to the flow of the current is the electrical resistance, which depends upon the material, the sectional area and length of the conductors and their temperature. The variations of conductor resistance with area, length, and temperature have been considered.

Dr. G. S. Ohm established the fact that the current strength in a direct-current circuit could be calculated by the formula now known as Ohm's law, which is, that the current in

$$\text{amperes} = \frac{\text{electromotive force in volts}}{\text{resistance in ohms}},$$

or, $\text{amperes} = \frac{\text{volts}}{\text{ohms}}$. That is, the current in amperes, flowing through a circuit is equal to the total electromotive force, in volts, acting in the circuit divided by the total resistance, in ohms, of the whole circuit.

EXAMPLE.—The terminals of a voltaic cell are connected by a conductor whose resistance is 1.6 ohms. If the internal resistance of the cell is 3 ohms and the total electromotive force developed is 1 volt, what is the strength of the current flowing in the circuit?

SOLUTION.—Since the external circuit is 1.6 ohms and the internal resistance 3 ohms, the total resistance is 4.6 ohms. Applying the rule just given for the formula,

$$\text{Current in amperes} = \frac{\text{electromotive force in volts}}{\text{resistance in ohms}}$$

$$= \frac{1}{4.6} = .217 \text{ ampere.} \quad \text{Ans.}$$

EXAMPLE 2.—The resistance of 20 cells in series is 60 ohms; the electromotive force of each cell is 1 volt; hence the electromotive force of the battery is 20 volts. (*a*) If the battery is short-circuited by a copper bar whose resistance can be neglected, what current will follow in the circuit? (*b*) If the resistance of the bar causing the short-circuit is 60 ohms, what will be the current?

SOLUTION.—(*a*) Since the resistance of the external circuit is so small as to be negligible, the total resistance of the circuit is that of the battery, or 60 ohms. Hence, the cur-

rent in amperes $= \frac{20 \text{ volts}}{60 \text{ ohms}} = .333$ ampere. Ans.

(*b*) The total resistance of the circuit is now $60+60=120$ ohms, and the current in amperes $= \frac{20 \text{ volts}}{120 \text{ ohms}} = \frac{1}{6} = .166$ ampere. Ans.

(To be Continued)

BOOK REVIEW

A review of the latest books on Mining and related subjects

Excavating Machinery, by Allen Boyer McDaniel. Published by McGraw-Hill Book Co., 328 pages, illustrated, $3 net. This book is divided into two parts, the first on Scrapers, Graders, and Shovels; and the second on Dredges. He takes up interestingly and successively, Drag and Wheel Scrapers, their use in various states, Road or Scraping Graders of various design, Elevating Graders, Capstan Plows, and Steam Shovels, the various types of shovels in use, where used, and their cost of operation. In Part II, the author classifies under Dry Land Excavators, the following: Scraper Excavators, Wheel Excavators, Tower Excavators, and Walking Dredges; under Floating Excavators he places Dipper Dredges, Ladder Dredges, and the Hydraulic or Suction Dredge. In discussing Trench Excavators he describes the five kinds in use, the Traveling Derrick, the Continuous Bucket Excavator, the Trestle Cable Excavator, and the Tower Cableway. He concludes the book with chapters on Levee Builders, the Comparative Use of Excavating Machinery, General Specifications for a Modern Steam Shovel for Railway Construction, and Tests of the Mississippi River Commission for Hydraulic Dredges.

Mineral Springs of Georgia. The Geological Survey of Georgia, S. W. McCallie, State Geologist, has issued Bulletin No. 20, which is a preliminary report on the mineral springs of Georgia. The book contains a history of the mineral springs, definition and origin of mineral waters, thermo springs, the medicinal value of mineral waters, a classification of these waters, together with their solid and gaseous constituents, their geographical distribution, and a description of individual springs and wells.

All of these springs, with only a few exceptions, have been regarded, from time to time locally, as possessing medicinal virtues. The report is profusely illustrated with half-tone cuts of various springs throughout the state.

Steam-Power Plant Engineering, by G. F. Gebhardt, Professor of Mechanical Engineering, Armour Institute of Technology, Chicago, Ill. Published by John Wiley & Sons, New York, N. Y. This work was first published in 1908, and many additions and changes have been made owing to the recent development of steam-power plants, which has made it necessary that it should be rewritten.

It is complete and of wide scope, and deals successively with Elementary Steam Power Plants; Fuels and Combustion; Boilers; Smoke Prevention, Furnaces, Stokers; Superheated Steam; Superheaters; Coal and Ash-Handling Systems; Chimneys; Mechanical Draft; Reciprocating Steam Engines; Steam Turbines; Condensers; Feedwater Purifiers and Heaters; Pumps; Separators, Traps, Drains; Piping and Pipe Fittings; Lubricants and Lubrication; Testing and Measuring Apparatus; Finance and Economics—Cost of Power; Typical Specifications; Typical Steam Turbine Stations; and a Typical Modern Isolated Station.

Black Powder and Dynamite. The Analysis of Black Powder and Dynamite is the title of Bulletin 51, Bureau of Mines. The bulletin is published for the information of all persons interested in explosives and their safe and efficient use in mining work. The reader is informed that the term "ordinary" dynamite, though much used, has no conventional meaning, and may be used to cover a wide variety of compositions of matter. It may be noted that the standard dynamite used at the Pittsburg testing station is a good example of the "ordinary" dynamite known in this country. Bureau's example ordinary dynamite: Nitroglycerine, 40 per cent.; sodium nitrate, 44 per cent.; wood pulp, 15 per cent.; calcium carbonate, 1 per cent. Those who order dynamite do not use the term "ordinary," but specify distinctly the percentage of nitroglycerine wanted. This standard of the Bureau of Mines is 40 per cent. nitroglycerine dynamite and not ordinary 40-per-cent. dynamite, which means that a particular dynamite has the same explosive force as a 40-, 50-, or 60-per-cent. nitroglycerine dynamite; at least this has been the writer's understanding of the matter.

General Metallurgy. In 1852 Frederick Overman, a political German refugee, died, but in that same year D. Appleton & Co. published his "Treatise on Metallurgy," which, it is believed, was the first American book on the subject. Since then no general metallurgy, so far as the writer knows, has been published in America, until Prof. H. O. Hofman's work which has been released recently by McGraw-Hill Book Co., of New York City. It is not to be understood that this "General Metallurgy" by Professor Hofman is intended to replace the excellent books on special metallurgical subjects, such as Ingall's Zinc, Hofman's Lead, Peters' Copper, etc., for it will not do so, besides that is not its aim. "General Metallurgy," as its name implies, was written with a view to covering metallurgy as a whole; therefore, in developing the theories of modern chemical, mechanical, and physical metallurgical researches the author makes use of mathematical calculations which in the last 20 years have grown so important in the curriculum. The book represents an immense amount of labor both on the part of the author and his colleagues, Profs. C. E. Fuller, E. F. Miller, M. DeK. Thompson, and C. R. Hayward, and will undoubtedly be welcomed by metallurgists in general. The price is $6.50.

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

35. What would be the resultant gases in the air of a mine after (1) an explosion of gas and coal dust, (2) the detonation of dynamite, and (3) an underground fire? What is the nature of the gases in each case, their effect on life, and the method of dealing with them?

36. A deep mine is dry and dusty. Discuss briefly the best method of keeping down the dust, and state how this may influence the method of working.

37. Sketch and describe how you would timber a main level (*a*) with a weak roof, strong sides and floor; (*b*) with a weak roof, strong sides, and weak floor; (*c*) with a strong roof, weak sides, and weak floor. Pay due regard to cost, and assume the seam to be a flat one.

38. Recently the steel wire rope at an anthracite mine pulled out of the ordinary socket with its usual rivets and clamping rings. Give the probable cause of failure and indicate by sketch the clamping you consider best.

Answers for Which Prizes Have Been Awarded

Ques. 29.—At a certain point *A*, a bore hole is put down 350 feet to a 6-foot seam of coal; at a point *B*, 2,500 feet due north of *A*, a bore hole locates the seam at a depth of 400 feet; at *C*, which is 2,000 feet west of *A*, a bore hole reaches the coal at a depth of 800 feet. What is the direction and the amount of dip of the coal, likewise the direction of its line of strike? Assume the elevation of *A* to be 1,850 feet, of *B*, 1,650 feet, and of *C*, 1,800 feet above mean tide.

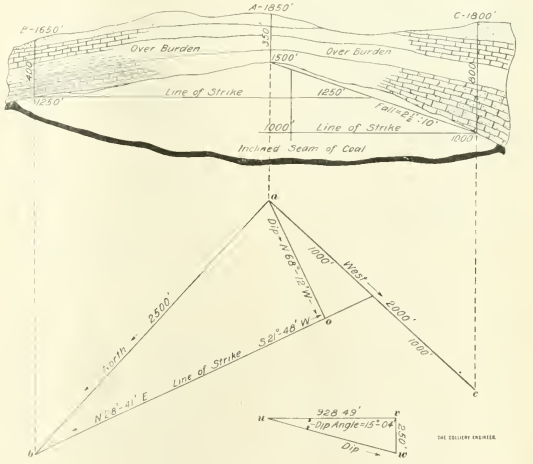


Fig. 1

Ans.—The sketch Fig. 1 represents the three drill holes *A*, *B*, and *C* on the surface.

As shown, the respective elevations of these holes at the surface are 1,850 feet, 1,650 feet, and 1,800 feet above mean tide. Their depths to the seam are 350 feet, 400 feet, and 800 feet. Subtracting the depth of each hole from its elevation at the surface gives the corresponding elevation in the seam, as shown in the sketch, 1,500, 1,250, and 1,000 feet above mean tide, respectively.

As stated in the problem, the two holes *B* and *C* were located, pre-

sumably with a transit, from the same point, which is at hole A. The survey was as follows: $A-B$ = North, 2,500 feet. $A-C$ = West, 2,000 feet. Draw a line in the seam joining the two holes having the least and greatest elevation, in this case A and C. The horizontal length of this line, as given by the survey, is 2,000 feet, its total fall, $1,500-1,000 = 500$ feet, or a fall of $2\frac{1}{2}$ in 10.

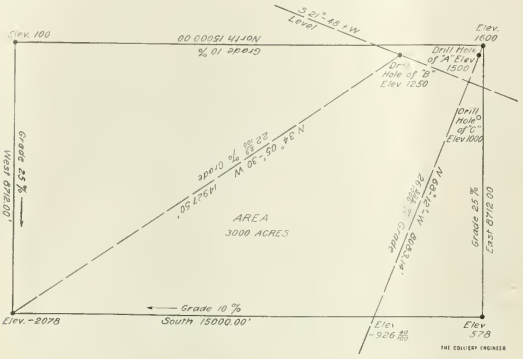


Fig. 2

Next, find a point in this line which has the same elevation as the hole B. This point is 1,250 ft. − 1,000 ft. = 250 feet above the bottom of hole C. And since the fall is $2\frac{1}{2}$ in 10, the distance of this point from hole C or the distance $x\,c$ in the sketch is $100 \times 10 = 1,000$. This determines the strike line (1,250) drawn from hole B, as shown in the sketch. Another line should be drawn from the bottom of hole C and parallel to this last line. This determines the strike line (1,000) drawn from the hole C.

Next solve the triangle $b\ a\ x$, to determine the direction of strike and the dip line at right angles to this.

Since the angle $b\,a\,x$ is a right angle the tan x may be found by the following formula:

$$\text{Tan } x = \frac{\text{side opposite}}{\text{side adjacent}} = \frac{2,500}{1,000} = 2.5,$$

which is the tangent of 68° 12′.

Since the bearing of the line $a\,x\,c$ is west, the direction of the strike will be 90° − 68° 12′ = S 21° 48′ W.

The line of dip being at right angles to the line of strike, its bearing is 180° − (21° 48′ + 90°) = N 68° 12 W.

To find the amount of dip it is necessary to solve the triangle $a\ o\ x$. The angle $a\ o\ x$ is a right angle and $o\ x\ a$ is 68° 12′, as found above; hence, the horizontal distance is $1,000 \times \sin\ x = 1,000 \times .92849 = 928.49$ feet.

We now have the triangle $u\ v\ w$ to solve the angle $v\ u\ w$. Since the tan of any angle of a right triangle $= \frac{\text{side opposite}}{\text{side adjacent}}$, the tan $u = \frac{250}{928.49} = .2692$, which is the tangent of 15° 04′. Therefore, the dip angle is 15° 04′.

D. E. Ingersoll,
Monon Coal Co.,
Terre Haute, Ind.

Second prize, C. T. Griswold, Pittsburg, Pa.

Ques. 30.—Assuming that a tract of 3,000 acres contains the seam of coal in Ques. 29, which has 2 feet of draw slate above it, that the coal pitches uniformly and its maximum elevation is 1,600 feet, how would you mine the coal, giving details of the size of pillars, etc.?

Ans.—Assume the tract of coal containing 3,000 acres to be rectangular in shape, having its boundary line north of a given point with an elevation of 1,600 feet above mean tide a distance of 15,000 feet, thence west a distance of 8,712 feet, thence south a distance of 15,000 feet, and thence east a distance of 8,712 feet to the place of beginning, as shown in Fig. 2.

From the location of the coal seam, as determined by the bore holes mentioned in Ques. 29, we know that the coal descends at the rate of 10 feet per 100 in a northern direction. Therefore, if the coal at the place of beginning is 1,600 feet at a point 15,000 feet north, the elevation will be 1,500 feet lower, or an elevation of 100 feet above mean tide, and in like manner we know that the coal dips to the west at the rate of 25 feet per 100; thence, if we go west of the 100-foot elevation a distance of 8,712 feet we descend 2,178 feet, or the elevation will be 2,078 feet below mean tide. And in like manner if we descend at the rate of 25 feet per 100 from the maximum elevation of 1,600 feet west, 8,712 feet or 2,178 feet, the elevation will be 578 feet below mean tide.

In Ques. 29 we found the direction of the line of strike to be 21° 48′ + (N E or S W) and line of dip to be N 68° 12′ W.

Assuming that the hoisting shaft is to be located at or near the drill hole B, my idea of mine lay-out would be as shown in Fig. 3, a loaded track running from hoist shaft S 17° 32′ W. This course will give a grade of 2 per cent., and at a distance of about 800 feet from center line of shaft a point of curve will be located, curve to left (with a radius of 250) of N 17° 32′ E. At a distance of about 400 feet from point of curve a hoisting engine should be placed.

From the point of curve a curved entry should be driven to a tangent having a course of N 34° $5\frac{1}{2}$′ W. This course will take the main entries to a point near the northwest corner of the property, or the lowest point. The sketch shows two air-courses, the haulage road, and a manway or intake air-course; overcasts are indicated by ×. Air coming in at the hoist shaft travels through the haulage road and manway and out the flats and back as shown by the

arrows. The face of the rooms being the highest place on each flat, any gas that may accumulate will be led off through the cut-through at the face of rooms.

Haulage.—By placing an engine with head-line drum only at point as indicated on sketch, empties may be dropped down around the curve to the flats, on which are located partings. Then with mules or small motors, they may be distributed to the working places. When the pitch of a seam is greater than 15 degrees, as it is in this case, coal may be conveyed by sheet-iron chutes from the face of the room to the entry.

By making the flats at a 1-per-cent. grade ascending, drainage and haulage will at all times be good. In Western Pennsylvania the direction of the flats would be near a face course and consequently all rooms would be butt rooms. This, of course, would not be as desirable as face rooms, as it requires about one-third more work and powder to mine, but the saving on trackage in rooms will more than offset this objection.

After making all developments, rooms may be driven on the retreat through to the flat above, and by starting at the face of each room, all or nearly all of the room ribs may be removed, and in like manner the entry pillars. FRED BROWNING

Brownsville, Pa.

Second prize, J. E. Jones, Danville, Ill.

QUES. 31.—If 25,000 cubic feet of air per minute pass through a 6′×10′ airway, what volume of air will pass through a 4′×5′ airway, the length of the airway and the power remaining the same? What will be the effect on the water gauge? Describe briefly what is understood by mechanical and manometrical efficiency of fans.

ANS.—The formula expressing the power required to circulate a given quantity of air in a given airway is $u=\frac{k\,l\,o\,q^3}{a^3}$. In this case, u, k, and l being constant, q varies as $\frac{a}{\sqrt[3]{o}}$ for each airway.

Let a = area of airway in square feet;
o = perimeter of airway in linear feet;
q = quantity of air passing per minute in cubic feet.

Second prize, Milton C. Evans, Kingston, Pa.

QUES. 32.—A steam engine of 300 actual horsepower is used for hoisting

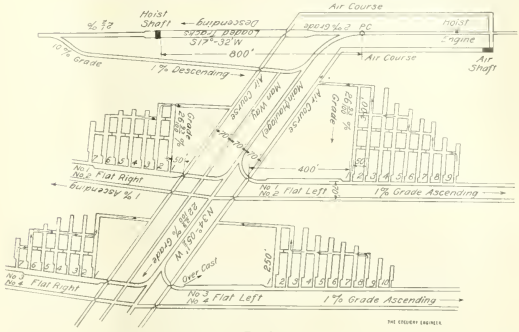


FIG. 3

Then, as $q_1 : q = \frac{a_1}{\sqrt[3]{o}} : \frac{a}{\sqrt[3]{o}}$. Substituting known values, and calling x the required quantity,

$$\frac{x}{25{,}000} = \frac{4\times5}{\sqrt[3]{2\,(4+5)}} \div \frac{6\times10}{\sqrt[3]{2\,(6+10)}},$$

$$\text{or } x = 25{,}000\times\tfrac{1}{3}\sqrt[3]{\frac{16}{9}}$$

$$= 10{,}095 \text{ cubic feet.}$$

The formula for expressing the pressure required to circulate a given quantity of air in a given airway is $p=\frac{k\,l\,o\,q^2}{a^3}$. In this case k and l are constant, and p varies as $\frac{o\,q^2}{a^3}$ for each airway. Using the same symbols as above and p = pressure,

$$\frac{p}{p_2} = \frac{32\times25{,}000^2}{60^3} \div \frac{18\times10{,}095^2}{20^3}$$

$$= \frac{1}{2.476};$$

hence, the effect on the water gauge is 2.476 times the water gauge reading of the larger airway. Mechanical efficiency is that per cent. of work produced by the fan engine above the required amount to overcome friction. Manometrical efficiency is that percentage of the total pressure generated by a ventilating fan that is efficient in blowing the ventilating current through a mine.

Hiteman, Iowa] EDWIN OAKLEY

600 tons of coal up a vertical shaft in 8 hours. Assuming the engine to be doing its best, making proper allowance for ordinary work such as the engine does in winding, find by calculation the depth of the shaft, and state in detail all extra work taken into consideration in determining the efficiency of the engine.

ANS.—Assumptions: Two compartments in the shaft, so that as one cage ascends with a loaded car the other is descending with an empty car.

Two cylinders.
Ten seconds for changes.
Five seconds for acceleration.
Cylindrical drum.
100 pounds steam pressure.
Five-eighths cut-off.
60 per cent. efficiency.
Piston speed 400 feet per minute.
Diameter of drum, 7 feet.
Length of stroke, $\frac{5}{4}\times$diameter of cylinder.

SOLUTION.—The first step is to calculate the winding speed. For this we will use the formula

$$(1) \qquad V=\frac{S\,\pi\,D}{2\,l}.$$

Where V = winding speed;
S = piston speed;
D = drum diameter;
l = length of stroke.

But before substituting these values we must first determine them as nearly as possible to conform with the data given.

We will base the calculations upon one cylinder, since one cylinder must be capable of doing the work.

Actual H. P. = 150

Indicated H. P. $= \frac{150}{60} \times 100 = 250$

(2) M. E. P. $= .9\,[K\,(P+14.7) - 17]$ (from table, $K = .904$) $= 78$ pounds, say 80 pounds per square inch.

(3) I. H. P. $= \frac{P\,L\,A\,N}{33{,}000}$

(4) $A = \frac{(\text{I. H. P.})\ 33{,}000}{P\,L\,N}$

$= \frac{250 \times 33{,}000}{80 \times 400} = 258$ square inches (approximately).

(5) Diameter of cylinder $= 2\sqrt{\frac{A}{\pi}}$

$= 18$ inches. The length of stroke may be taken as five-thirds times the diameter of cylinder.

Length of stroke $= 2.5$ feet. Now we can substitute in formula (1),

$$V = \frac{\pi \times 7 \times 400}{2 \times 2.5}$$

$= 1{,}859$ feet per minute.

The next step is to find the load the engine will lift.

(6) $\frac{P\,l}{2} = L\,R$

Where L = load on engine;
P = total pressure;
l = length of stroke;
R = radius of drum.

$L = \frac{P\,l}{2\,R}$

$L = \frac{258 \times 80 \times 2.5}{2 \times 3.5} = 7{,}371$ pounds.

This load of 7,371 pounds is the actual load, which in this case is the sum of the weight of material, weight of rope, friction, and acceleration.

Allow 10 per cent. of the gross load for friction and acceleration, and deduct this from the actual load to get the net load.

One load of material		
+rope	= say	5,800
Two cages	= say	6,000
Two cars	= say	4,000
Gross load	=	15,800
10 per cent. of load	=	1,580

Actual load $7{,}371 - 1{,}580 = 5{,}800$ pounds, approximately, net load.

This load of 5,800 pounds must be divided between the weight of coal hoisted each trip and the weight of the rope.

The greatest load on one end of the rope is the sum of the weight of material, weight of rope, weight of one car, weight of one cage, and force due to friction and acceleration.

One load of coal		
+rope	=	5,800
One cage	=	3,000
One car	=	2,000
10 per cent. of gross load	=	1,580
		12,380 pounds,

or 6.2 tons.

The rope that is best suited for this load is a $\frac{7}{8}$-inch plow-steel rope, which has a breaking load of 34 tons, a proper working load of 6.8 tons, and weighs 1.2 pounds per linear foot.

By an equation,

$$5{,}800 = 1.2\,d + w;$$

(7) $w = 5{,}800 - 1.2\,d;$

where d = depth;
w = weight of coal.

(8) $n = \frac{o}{w}$

where n = number of trips;
o = pounds per hour.

We may also get another value for n from the winding speed and depth of shaft.

Allowing 15 seconds each trip for changes and acceleration, we have 45 minutes left in each hour for the winding speed of 1,860 feet per minute. This gives an average speed of $\frac{45}{60}$ of $1{,}860 = 1{,}395$ feet per minute.

(9) Now, $n = \frac{1{,}395 \times 60}{d}$

(8) And, $n = \frac{o}{w}$

Six hundred tons per day of 8 hours is equivalent to 75 tons per hour, or 150,000 pounds per hour.

(10) $w = \frac{o\,d}{1{,}395 \times 60} = \frac{150{,}000\,d}{83{,}700}$

[From (8) and (9)]

(7) But $w = 5{,}800 - 1.2\,d$.

Equating then:

$$\frac{150{,}000\,d}{83{,}700} + 1.2\,d = 5{,}800$$

$$d = \frac{4{,}854{,}600}{2{,}504.4} = 1{,}938.4 \text{ feet.} \quad \text{Ans.}$$

(7) $w = 5{,}800 - 1.2\,d$
$= 5{,}800 - 2{,}326$
$= 3{,}474$ pounds.

Practically $1\frac{3}{4}$ tons in each car and a hoist that will approximate 2,009 feet.

J. E. Jones

Danville, Ill.

Second prize, Wm. Phillips, Cuddy, Pa.

Birds in Coal Mines

Canary birds have been found by the Bureau of Mines to be the most efficient watchers against deadly carbon monoxide gas in mines, so the mine-rescue cars carry a number of canaries to be used in the event of mine disasters when the rescuers begin work. In a recent test it was found that a canary bird showed signs of distress in 3 minutes after being exposed to air that contained one-sixth of 1 per cent. of the gas and fell off its perch after 8 minutes, while a mouse did not show any effects for an hour. Guinea pigs are also susceptible more than men to the gas, but the canaries are the best and in addition are a pleasant addition to the equipment. Many miners are now using canaries to watch out for the gas while they are at work.—*Saturday Evening Post.*

It seems strange that writers for non-technical periodicals cannot get items on coal mining right. The above quotation from the *Post* is correct in all particulars but the last sentence. The writer has an entirely wrong conception of the use of canaries by the working coal miners.

The facts are, the miners purchase only the best singers, that is birds that sing constantly. When taken in the mine, the bird is confined in a small cage, a cap piece attached to a small armored rubber tube is placed over his head, and this in turn is attached to a compressed-air engine connected with an electric generator. Then, the bird, instead of wasting its breath in song, uses the energy thereof in operating the engine, which in turn operates the dynamo. The electric current thus obtained is used principally for operating electric mining machines, the excess being accumulated in storage batteries, which furnish power for pumping, when in wet seasons the ordinary plant requires additional power.

Answers to Examination Questions

Questions Asked at the Examination for Fire Boss Held in Birmingham, Ala., January 21, 1913

Preliminary Questions.—(1) Give number you are standing examination under. (2) Give your full name. (3) Give place of your birth. (4) What is your age? (5) What class of certificate are you standing for? (6) Where should your certificate be mailed?

Ans.—The answers to these six introductory questions are naturally different for each candidate.

Ques. 1.—State what experience you have had in mines in this or other states. Give names and locations of gaseous mines in which you have been employed; the length of time employed in each, and the different capacities in which you obtained such experience. Answer fully.

Ans.—The answer to this question will, also, be different for each candidate. While the answer should contain all the information asked for the details should be given in as few words as possible.

Ques. 2.—Under the Alabama Mining Law what are the duties of a fire boss?

Ans.—He must examine every working place in the mine before men are permitted to enter. He must be at some convenient place for at least 1 hour before work begins so as to inform each man as to the state and condition of his working place so far as gas in dangerous quantities is concerned. The work must be examined every morning with a safety lamp before men are allowed to enter. After each examination he must leave at a point at least 25 feet back from the face of each slope, drift, entry, or air-course and at the neck of each room examined, a conspicuous sign or mark indicating the presence of gas in dangerous quantities. In addition he must leave a memorandum of the date of his examination.

Ques. 3.—Name and describe some of the important differences between the Davy, the Clanny, and the Wolf safety lamps.

Ans.—The Davy is the original form of safety lamp and consists essentially of a brass lamp holding oil, surmounted by a gauze cylinder with closed top. The gauze is surmounted by a gauze cap enclosing the flame of the lamp, which cap is double at the top where it is most liable to be burned through or to become hot and pass the flame. The gauze is made of what is known as 28-mesh wire and has $28 \times 28 = 784$ openings per square inch of surface.

The Clanny lamp is an improvement upon the Davy in that the lower part of the gauze is replaced with glass, affording more light. In the Davy lamp the air enters all around the gauze and below the level of the flame whereas in the Clanny lamp, while the air enters at the base of the gauze yet it comes in above the flame above the glass chimney. This is apt to cause smoking from a conflict or intermingling of the ascending and descending currents of air.

The Wolf lamp is an improvement upon the Clanny. It burns benzine, or naphtha, which affords a better light than oil with less smoke and a more uniform flame cap. It is also provided with an igniting device (friction) by which it may be relit if accidentally extinguished. It is provided with a magnet lock which can only be unlocked by means of a powerful magnet kept at the proper place.

Ques. 4.—Why does firedamp explode in a safety lamp without producing an explosion of the gas with which the lamp is surrounded?

Ans.—The passing of the flame from the lamp to the outside air is prevented by the gauze. This splits the burning gas into little streamlets (784 to each square inch of gauze), which are cooled below the point of ignition, that is, are extinguished by coming in contact with the metal of the gauze, so that the flame does not pass outside the lamp. In some cases the explosion may be so great as to force the flame through the gauze and thus ignite the gas outside.

Ques. 5.—How many apertures are there in a square inch of standard safety lamp gauze?

Ans.—As noted in the answer to Ques. 3, there are $28 \times 28 = 784$ openings to the square inch.

Ques. 6.—Are there any conditions under which it would not be safe to use a safety lamp? If so, name them.

Ans.—The underground conditions affecting the safety of the lamp are exposure in air-currents of high velocity by reason of which the flame may be blown through or against the gauze, or exposure for too great a time to mixtures of air and gas which will burn within the lamp and thus heat the gauze. The dangerous velocity of air-currents begins at about 500 feet a minute, but varies with the type of lamp, some being much less sensitive to air-currents of high velocity than others. Other conditions under which the lamp is not safe concern the lamp itself or the one using it. The lamp is dangerous in the hands of inexperienced persons or when the gauze is dirty or broken. If the gauze is dirty, that portion

absorbs the heat and may become hot enough to ignite the outside gas; naturally any holes in the gauze will pass the flame.

Ques. 7.—If an explosion should occur in a safety lamp, what would you do?

Ans.—The lamp should be slowly lowered or removed from the gas avoiding any sudden, quick motion which might force the gas through the gauze.

Ques. 8.—What kinds of safety lamps have you used in places where firedamp was known to exist? Which lamp do you prefer, and why?

Ans.—The first part of this question must be answered according to the individual experience of the candidate. If the number in use is a guide, the Wolf lamp has the preference over others in American mining practice. It has the desirable features of the best lamp and in addition gives the maximum of light, may be relit with safety in the mine, and is very safe in air-currents of extremely high velocity.

Ques. 9.—Give the names, chemical symbols, and composition of the different gases met in coal mines.

Ans.—There are two simple gases which are universally present in mines and one very rarely so, as follows: Nitrogen, symbol N, and oxygen, symbol O, which compose, respectively, about 80 per cent. and 20 per cent. of the air; hydrogen, symbol H, is sometimes found, particularly from leakage from natural gas wells. The compound gases are: Carbon dioxide (carbonic acid, blackdamp, chokedamp, and now very commonly called merely dioxide or dioxide gas), symbol CO_2, composition by weight, carbon, 27.27 per cent. and oxygen, 72.73 per cent.: carbon monoxide (carbonic oxide, whitedamp, and more recently only monoxide or monoxide gas), symbol CO, composition by weight, carbon, 42.86 per cent. and oxygen, 57.14 per cent.; methane (light carbureted hydrogen, marsh gas, and sometimes firedamp, or merely gas), symbol CH_4, composition by weight, carbon, 75 per cent. and hydrogen, 25 per cent.; hydrogen sulphide (sulphureted hydrogen or stinkdamp), symbol H_2S, composition by weight, hydrogen, 5.88 and sulphur, 94.12; ethane (ethylene or olefiant gas), symbol C_2H_4, composition by weight, carbon, 85.71 and hydrogen, 14.29. Of these gases hydrogen and ethane are very rarely met, the others are more common.

Ques. 10.—What dangers may arise from improperly putting together a safety lamp?

Ans.—The danger is that there may be a leakage of air through some open joint by reason of which a mixture of gas and air burning within the lamp may be communicated to the outside and thus cause an explosion.

Ques. 11.—If you were a fire boss and had a working place which had been showing gas on several consecutive inspections, and, then on your next inspection of such a place you found no gas, what would be your procedure?

Ans.—Nothing can be done aside from cautioning the men, who should be working with safety lamps, to be on the watch for the possible return of the gas, which return should be reported to the fire boss, mine foreman, or superintendent at once.

Ques. 12.—Is it possible to have an explosion in a mine when your lamp gives no indication of the presence of firedamp?

Ans.—Yes. The dusts of most bituminous coals are highly explosive in the presence of small amounts of gas, even when less than 1 per cent. is present, which is an amount much less than that which can be detected by an ordinary safety lamp. Furthermore, coal dust may be exploded when gas is entirely absent from the workings. The agents causing the dust to explode are a blown-out shot or an explosion of loose powder, dynamite, etc.; the flame made by the short circuiting of an electric current of high potential, as when the trolley wires fall; or a mine fire. In all cases the finer and dryer the dust the more easily is an explosion started.

Ques. 13.—After your examination of a mine, what evidence would there be to show that you had examined all the working places therein?

Ans.—A mark must be left at least 25 feet back from the face of each slope, drift, entry, or air-course, and at the neck of each room examined, indicating the condition of the place so far as firedamp is concerned together with the date of the examination.

Ques. 14.—Is it necessary to make an examination for gas in an abandoned place which has a room working next to it?

Ans.—Yes; because the men in the working place may enter the abandoned room, or the gas may escape from it into the working place.

Ques. 15.—How often is it necessary to examine the worked-out rooms on a working entry in a very gaseous mine?

Ans.—They should be examined every day for the reason given in the answer to the last question. These rooms should be fenced off and so marked that men will not enter them. In some of the larger mines it is the custom to seal up all abandoned rooms with air-tight masonry or concrete walls so that men cannot enter or gas escape.

Ques. 16.—If you should discover a large body of explosive gas in abandoned rooms on a working entry, what would be your duty as fire boss?

Ans.—All that the fire boss is legally called to do is to make some mark on the room neck indicating the presence of gas and to date the same. If there is no gas in the working rooms, there is no reason why the men should not continue at work under ordinary conditions. On the other hand if the roof is continually falling or a squeeze is on, the men should not be allowed to enter their places until the gas in the old rooms has been removed, as the falls of roof or the squeeze may force dangerous amounts of gas from the abandoned into the active workings.

Ques. 17.—What other duties should a fire boss be held responsible for other than detecting gas.

Ans.—Legally there are no other duties than those given in the answer to Ques. 2. On the other hand the the fire boss is morally obliged to investigate and report any condition of affairs that will affect the safety

of the men and the welfare of the mine. He is especially concerned with reporting the condition of the roof, falls of which cause over half the deaths in our mines. He should see that the brattices, doors, and overcasts are in good order; that the dust is kept down and properly watered where necessary. In other matters he acts (usually) as assistant to the mine foreman and carries out his orders.

Ques. 18.—If you were a fire boss and arrived at the mine late, and found you had time to examine all but one entry, before you allowed the men to enter what would you do?

Ans.—Post a notice at the mine mouth for the men not to enter the entry which could not be examined. Also, if the mouth of the entry is passed on the way in, a board or other obstruction should be laid across its mouth with proper markings to indicate that there was gas in that entry and the men were to keep out. The foreman and superintendent had, also, better be notified.

Ques. 19.—If you were a fire boss in a mine where the seam was pitching, and you discovered several working rooms contained gas, which would be the best way of removing this gas, by brushing or by sweeping it out by ventilation?

Ans.—The only safe and proper way of removing gas is by carrying the ventilating current up to the face.

Ques. 20.—What should be the first thing for you to observe on entering the mine as fire boss for duty?

Ans.—Note if the usual and proper amount of air is coming in through the main intake.

Ques. 21.—What would be the first thing to observe on entering each entry for examination?

Ans.—Note if the customary amount of air is entering it. If the entry commonly contains gas and the proper amount of air is entering through the main intake of the mine, test for the presence of gas.

Ques. 22.—What percentage of air mixed with marsh gas will start an explosion; and what is the highest limit and what is the diminishing point?

Ans.—This question is commonly reversed, the requirement being to state the percentage of marsh gas in the air, and is so answered here. The smallest amount of methane which will start an explosion is 7.14 per cent. (air, 92.86 per cent.); the highest limit is reached when the air contains 9.46 per cent. of methane (air, 90.54 per cent.); and the diminishing point is reached when the air contains 16.67 per cent. of methane (air, 83.33 per cent.). It should be understood that much smaller amounts of methane than 7.14 per cent. will cause an explosion in dry and dusty mines in the presence of a blown-out shot, an electric arc, etc.

Ques. 23.—What do you assign as the cause of the greatest number of explosions of firedamp?

Ans.—Open lights coming in contact with small pockets of the gas.

Ques. 24.—State your views as to the causes of explosions, and what precautions you would adopt to prevent them.

Ans.—The chief cause of explosions in bituminous mines is the ignition of the dry and finely powdered dust, which ignition may be assisted by the presence of small percentages of methane in the air. The dust is most commonly ignited by the flame of a blown-out shot or the explosion of a considerable quantity of powder or dynamite taken into the mine for blasting. Other means of igniting the dust are the electric arc produced by the short circuiting of a high-tension current, and more rarely a mine fire or a gas explosion. Explosions of gas alone, unaided by dust, are rare in bituminous mines, and the destructive effects are usually confined to a limited area near the point of origin. It is the presence of dust that causes the explosion to penetrate all portions of the mine with general loss of life and destruction of property.

Anything that will reduce the quantity of dust will limit the number of explosions. The face should be undercut and (if possible) sheared before the coal is blasted; under no circumstances should shooting off the solid be permitted. Dust should not be allowed to accumulate at the working faces or on the entries and should be loaded out. Cars should be tight and should not be overloaded, so that dust may not filter through the cracks in the planking or lumps roll off to be ground into powder by men and mules. Permissible powder should be used, and the placing, charging, and firing, of the holes should be done by careful men. The rooms for some distance back from the face should be washed or wetted down before shots are fired. Some means of moistening the mine air should be used in order that the entering air may not absorb moisture from the workings and thus render them dusty. This may be accomplished by turning live steam into the intake or by placing water sprays at intervals through the mine. Not infrequently both steam and sprays are used. In some mines the roof, floor, and ribs are washed down with a hose. This is a most excellent practice where water is available. Where water is not to be had, finely powdered rock dust may be thrown upon the coal dust to reduce its explosibility.

State Geologist H. A. Buehler, of Missouri, says: "Many oil excitements are the result of finding a small scum on the surface of stagnant pools having every appearance of kerosene. The scum is the result of iron in the water and is in no way connected with oil or gas pools. If collected in a glass or bottle this material soon sinks to the bottom as a brownish-red precipitate while crude oil will continue to float. This similarity to an oil scum is often used by the promoter to show the presence of oil." A stone dropped in the pool will crack the scum, which will not run together as will oil scum on water.

Much of the so-called silk nowadays is made of wood. Germany produces more than 1,000,000 pounds of this cellulose silk, worth $1,500,000. A ton of wood worth $10 yields cellulose worth $20, and this cellulose yields silk worth $850.

NEW MINING MACHINERY

The Eureka Timber Hook

Every miner is familiar with the "cant-hook," a tool for turning and assisting in the handling of timbers and logs. It consists of a lever and hook. The cant-hook is used to advantage only from the side, and if the miner wants to skid a tie or timber along the ground he must use a pick of some kind, or if he wants to raise one end he must use his hands, for the cant-hook, when used endwise of a timber is not capable of preventing it from turning.

The useful tool shown in Fig. 1, called the "Eureka Tie and Timber Hook" is an improved cant-hook. While the tool was originally designed for handling sticks about a timber treating plant, a mining engineer, L. S. Ropes, of Helena, Mont., recognized at a glance that it would be a useful tool for the timber shed outside, and for the trackmen and timbermen underground, as the former could snake ties with it, while the latter could lift, snake, and turn timbers, making it a somewhat universal tool. The hook has two points which furnish a double hold, while the underside end of the lever has two spurs which prevent the stick from rocking or swivelling when taking an end lift as shown. The point on top of the lever at the end is a "come along John," useful when snaking ties or timbers. It was this point and the two spurs coupled with other considerations that suggested the name "horned toad" for this tool, but which will probably be abbreviated to the simple mine vernacular "toad."

It is difficult for one to imagine the timber boss so far forgetting his surroundings as to say to his helper: "James approach with the Eureka tie and timber hook," when, "Jimmy bring the toad," will answer.

Fig. 1

New Mine Section Insulator

The Ohio Brass Co. has recently brought out a device for insulating certain sections of main- and butt-entry trolley wires. It consists of a hickory beam to which are attached bronze end castings for the different styles and sizes of wire. The center piece instead of being insulated as in other breakers is made of metal and is arranged to rotate. On top, and connected with this center piece, is a heavy copper contact blade which is connected to the center piece and which engages with suitable clips on the bronze end castings.

The device is shown closed in the operating position in Fig. 2, showing the smooth unbroken metallic underrun entirely across the insulator, which eliminates all trouble from arcing at this point and allows the trolley wheel to pass over without jar or break. Fig. 3 shows the device in the open or insulated position, and shows clearly the method of its operation.

This construction gives a double break, thus minimizing the arcing and burning of the contact blade and the clips. This is a desirable feature as it has been found in many cases a locomotive driver will accidentally run across an insulated section insulator with the power on, the result being a heavy rush of current to the motors, a heavy strain on the gears and armatures, liability of the flashing over at the commutator, and a sudden drain of current from the power house, with attendant annoyance to operators and possible damage to apparatus.

Ample copper is provided in the switch blade and clips, so that the device has a much greater carrying capacity than the largest size of trolley wire with which it will ever be used. In addition, the metallic center piece acts as conductor of the current. Up to the present time it is furnished only for 4/0 round and grooved wires.

Fig. 2. Mine Section Insulator

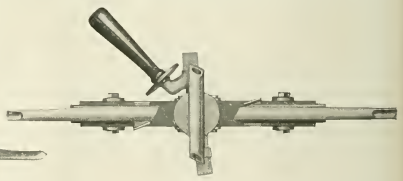


Fig. 3. Switch Open—In Insulated Position

Improved Automatic Water Gauge

The improved automatic water gauge shown in Fig. 4, was designed and patented by The Lunkenheimer Co., of Cincinnati, Ohio.

It is made in two patterns, for 200 and 300 pounds working pressures, respectively, either right or left hand,

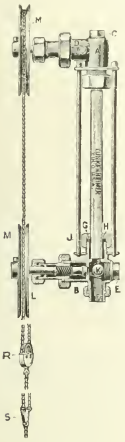


Fig. 4

as desired, to facilitate the operation of the gauge.

Should the gauge glass break, the ball check-valves *K* will automatically seat, owing to the rush of steam and water on one side, and the lack of pressure on the other. This automatic closing feature prevents the escape of steam and water, and permits the safe closing of the hand-operated valves for the purpose of renewing the glass.

To renew the glass, it is only necessary to loosen the stuffingboxes *G*, take off the cap *C*, remove the broken glass and substitute a new one, after which the stuffingboxes are tightened and the cap *C* replaced. The change can be performed with perfect safety, for, owing to the quick-closing valves, there is no danger to be anticipated from escaping steam and water.

By the arrangement of pulley wheels *M* both valves can be made to positively seat independently of each other. This arrangement consists of a block pulley operating over a chain, which is pinned to both the upper and lower pulleys, this method being employed for closing the valves. Should one of the valves become closed before the other, a continued pull on the block chain will close the other.

The Lunkenheimer company has issued an attractive booklet thoroughly describing and illustrating this gauge, which they are distributing free to any one desiring a copy. The gauge has been given the trade name of "Monitor."

McKesson-Rice Screenless Sizer

The screenless sizer is a machine adapted to separate dry granular material into different sizes without using any form of screen in which apertures of fixed dimensions determine the size of the products.

The screenless sizer is intended to eliminate the common disadvantages of screens, such as frequent renewal due to constant wear and tear, reduction of efficiency due to the clogging of the apertures, and lack of flexibility.

The machine consists of a gable base frame on which are mounted two inclined decks or separating surfaces, the inclination of which is varied from 30 to 40 degrees, according to the material treated. Horizontal motion is imparted to the table by a shaking device, the length of the stroke being adjustable from $\frac{5}{16}$ inch to $\frac{3}{4}$ inch, and the number of strokes varying between 250 and 285 per minute. The horizontal motion is modified by a toggle arrangement on which the table rests, to give simultaneously an upward and forward motion.

By reference to Fig. 5 it will be seen that the surface of the table is separated into a series of deflectors, arranged transversely to the long dimension of the table.

The surfaces of these deflectors are corrugated, forming a series of ridges, the line of the ridges being practically at right angles to the edge of the deflectors. The height of these corrugations or ridges is calculated for the size of particles it is desired to separate and progressively diminished from the feed-end across the table.

Adjustable dividers are placed along the bottom edge of the table so that the product from any one or more deflectors can be collected separately.

The feed is divided and delivered uniformly to the two decks. The standard size of each deck is approximately 6 ft. × 8 ft., but this may be varied to suit any condition. The deflectors are arranged for the number of sizes into which the material is to be separated. For instance, if four sizes are desired, only three deflectors would be required.

The capacity of the table will vary according to the number of grades and the sizes of products desired. It will be greater with coarse material and few sizes, and less with fine material and many sizes. The width of the deflectors, the depth of the corrugations, and their line of direction are varied to suit the needs.

The unsized material is fed at the upper corner of one end of the deck by any form of continuous mechanical feeder. It is immediately spread by the table motion, and each particle tends to roll down by force of gravity. This tendency is arrested by the corrugations or ridges.

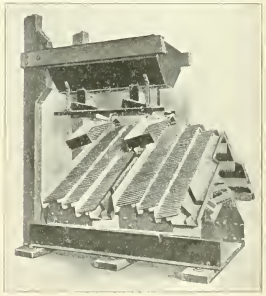


Fig. 5. Screenless Sizer

A particle of large size, the center of gravity of which is above the top of the ridges, will roll downward. The other particles will be caught in the grooves between the ridges and will be gradually propelled forward and upward in the grooves, dropping from one deflector to the next, until they reach a deflector over the corrugations of which they may roll.

The effect of specific gravity is entirely eliminated in this device. An intimate mixture of various sizes of light and heavy particles, such as cork and lead, can be separated into a number of products, in each of which cork and lead particles of the same size will appear.

Advantages claimed for the screenless sizer over the ordinary screening devices are equal cost of installation with greater uniformity of product; greater flexibility in changing the size of the products; satisfactory sizing of flat products which is impossible in a screen; less power required; less cost of maintenance; and dusting of friable material reduced to a minimum.

Rotary Power Pump

A new type of rotary power pump has recently been developed by The Goulds Mfg. Co., Seneca Falls, N. Y. This pump differs from the rest of the line of pumps of the same capacity in that gear style cams, as shown in Fig. 6, have been substituted for the three-toed cams used in the remainder of the line, and the gears on the end of the cam-shafts have been eliminated.

Two sizes are built: No. 1 has a capacity of 25 to 50 gallons per minuts at 225 to 450 revolutions, and No. 2 has a capacity of 50 to 100 gallons per minute at 225 to 450 revolutions. Both pumps are suitable for pressures up to 100 pounds, or 230 feet elevation.

They are mounted on a cast-iron bedplate, fitted with an outboard bearing and tight and loose pulleys for belt drive. The suction connection is made within the base directly beneath the case and is reached through hand holes in the base. No. 1 has two discharge openings, one tapped for pipe and the other threaded for hose couplings; No. 2 has three discharge openings, two fitted the same as No. 1, and the third fitted with an interchangeable blank flange.

Fig. 6.

The suction is 3-inch on No. 1 and 4-inch on No. 2. The discharges are for 1½- and 2-inch pipe or hose, respectively.

TRADE NOTICES

Telephones for Oklahoma Mines. The Oklahoma Coal Operators' Association through its representative, Carl Sholz, president of the Coal Valley Mining Co., has awarded a contract to the Western Electric Co., for 800 mine telephones with complete wiring and installing material which is said to be the largest order ever placed at any one time for such equipment.

The Webster Mfg. Co. announces that Mr. T. K. Webster, for many years its president, and one of the principal stockholders, has severed his connections with the company. The personnel of the board of directors and officers is as follows: F. S. Shaw, President; A. T. Perkins, Vice-President and General Manager; Alex. Kiskadden, Vice-President; Chas. S. Clarke, Treasurer; L. H. Webster, Secretary. Board of Directors: F. S. Shaw, Chicago; A. T. Perkins, Tiffin, Ohio; E. P. McPherson, Chicago; R. D. Sneath, Tiffin, Ohio; Chas. S. Clarke, Tiffin, Ohio; Alex. Kiskadden, Tiffin, Ohio; Geo. D. Loomis, Tiffin, Ohio.

Asbestos Roof Stops Conflagration. The ability of asbestos roofing to resist fire and check the progress of a blaze was demonstrated by a fire which broke out in one of the sheds of the Export Lumber Co., Charlestown, Mass., and in a short time reached such proportions that the fire companies, were temporarily powerless to check it. The fire burned its way from the sheds of the Export Lumber Co. to a large storehouse covered with asbestos roofing. The falling embers and sparks had no effect on this roofing and the fire department was enabled to concentrate its energies on the advancing wall of flame, with the result that the fire was gradually gotten under control. The roofing that so effectively put a stop to this conflagration is known to the trade as J-M Asbestos Roofing, manufactured by the H. W. Johns-Manville Co., of New York. It is composed of a felt made from asbestos rock reduced to fibers. Layers of this stone felt are cemented together with Trinidad Lake asphalt, the whole forming a roofing that is literally a sheet of flexible stone. The Johns-Manville Co. have branches in all the principal cities, and have recently opened a new one in Charlotte, N. C.

Special Notice.—The National Tube Co. announces that commencing August 1, 1913, it will enter the electrical conduit field. It has contracted with the National Metal Molding Co. and the Safety-Armorite Conduit Co., both of Pittsburg, Pa., to manufacture and sell this product as their agents under their various brands. This product will be sold on the "Pittsburg basing discount" plan in the same manner as all wrought pipe for other purposes has been sold for the past 13 years.

Change of Location.—Hirsch Electric Mine Lamp Co. has moved its factory to the S. W. Cor. Twelfth and Wood Streets, Philadelphia, Pa., in order to increase its facilities for manufacturing of the "Hirsch" Electric Mine Lamp.

Coal Cleaning Plant.—The E. E. White Coal Co. has contracted with Link-Belt Co. for an addition to the plant at Stotesburg, W. Va., which the Link-Belt Co. installed in 1912. At present a Link-Belt chain retarding conveyer delivers the run-of-mine coal direct to cars, and the improvement consists of the addition of shaking screen, picking tables, and loading room equipment. Under this new arrangement the coal will be very carefully sized, and the picking table and loading rooms will afford easy means for hand picking, and insure delivery of the egg and lump sizes to cars, with practically no breakage and in the cleanest possible condition. The Link-Belt Co. has also contracted for the construction of a Link-Belt picking table and electrically operated loading boom for the United States Coal and Oil Co., at Holden, W. Va., and for a screening and picking equipment for the Valley Smokeless Coal Co., Mine No. 2, at Johnstown, Pa.

Canadian Plant.—The B. F. Sturtevant Co., of Canada, Ltd., has arranged for a plant at Galt,Ontario, Canada, to manufacture the same lines of apparatus as are made by the B. F. Sturtevant Co., of Boston. This plant will be fully equipped to supply the Canadian trade and also export to foreign countries. The manufacturing, engineering, and sales will be handled by men trained by the B. F. Sturtevant Co., of Boston, and the general policy of that company will be carried out. Some of the more important apparatus which will be built are fans and blowers, planing-mill exhausters, propeller fans, heating and ventilating apparatus, fuel economizers, mechanical draft, steam turbines, vertical engines, generating sets and stokers.

New York Office.—The Electric Railway Equipment Co. reports that owing to increased business it has moved its eastern office to Hudson Terminal Bldg., 30 Church Street, New York City. Mr. J. G. Kipp is still in charge.

Injunction.—On June 25, 1913, the long continued litigation between the Christy Box Car Loader Co., of Des Moines, and the Ottumwa Box Car Loader Co., of Ottumwa, was brought to a close by the decision rendered by Hon. Smith McPherson, Judge of the Federal Court, who held that the Ottumwa Box Car Loader Co. was infringing the Christy patents. The infringing company, its officers, agents, and employes, under decree, are permanently restrained from the further manufacture, sale or use of the infringing box-car loader or any box-car loader which may infringe upon Nos. 1 and 2 of the patents of The Christy Box Car Loader Co. The courts further denied a motion for a supersedeas bond. This denial prevents the Ottumwa company from making, using, or selling the infringing machine.

Insulation of Steam Lines.—At a meeting of the National District Heating Association held at Indianapolis on May 13, last, Mr. H. W. Prentis, Jr., Manager of the Publicity Department of the Armstrong Cork Co., of Pittsburg, Pa., read a very interesting illustrated paper on "The Insulation of Underground Steam Lines," which contains a great deal of information of value to steam users, and particularly to managers of coal mines where steam is carried any considerable distance from the boilers to the point of utilization. Some years ago the matter of fuel economy at coal mines was given but little if any attention, and conditions were such that steam pressure that today is considered inefficient was considered satisfactory. Intelligent mine managers of today realize that economy in the use of fuel is as important as economy in other lines, and they welcome any suggestion that will not only effect such economy, but which will, at the same time, insure dry steam of higher pressure at the point of utilization.

Experience has shown that steam pipes carried into the mine, unless well insulated, have caused heavy expense due to dry rot in timbers and to rapid disintegration of certain roof rocks, as well as extra fuel expense and less efficient service. In his paper, Mr. Prentis presents some ideas of real value, which while primarily prepared for the National District Heating Association, will be found interesting and profitable by mine managers.

Business is Good.—The Roberts & Schaefer Co., of Chicago, report great activity in their line. During 10 days recently the following work was contracted for:

The Ohio Cannel Coal Co., Coshocton, Ohio, a complete coal mining plant, price $40,000; Big Creek Colliery Co., Chicago, a complete mining plant at St. David, Ill., at the site of the plant destroyed by fire on August 5, price approximately $25,000; The Grand Trunk Railway, a 600-ton Holmen coaling station at St. Lambert, Quebec, price $17,000; The National Fuel Co., Denver, Colo., a Marcus patent picking table screen in steel tipple for the Monarch mine, Louisville Junction, Colo.; The Montevallo Mining Co., of Birmingham, Ala., a Stewart coal washing plant at Aldrich, Ala., price $15,000; The Forester Coal and Coke Co., Du Quoin, Ill., a 300-ton locomotive coaling station on the Illinois Central Railroad; The Hutson Coal Co., a Marcus patent picking table screen mine tipple at Hopedale, Ohio, price $17,500.

The American Concentrator Co., of Joplin, Mo., have effected an arrangement whereby the Roberts & Schaefer Co. are to design and build the new coal washing plant for the Tennessee Coal, Iron, and Railroad Co., at Birmingham, Ala., for which the American Concentrator Co. recently contracted, and in which plant their "Elmore" coal jigs will be used.

Electrical Equipment.—The following list of equipment recently furnished by the General Electric Co. shows the rapidity with which electric machinery is being introduced into mines: The Pleasant Valley Coal and Coke Co., McAlester, Okla., a 625 kv-a. Curtis turbogenerator, 50 kv-a. and 75 kv-a. transformers, switchboard panel and accessories, 35-horsepower, 37½-horsepower, 50-horsepower, and 75-horsepower motors. The Peacock Coal Co., Pomeroy, Ohio, a 50-kilowatt Curtis

condensing turbogenerator; a 200-kilowatt synchronous motor-generator set; six 75 kv-a., three 100 kv-a., and three 200 kv-a. transformers, and three 200-horsepower motors. The Consolidation Coal Co., Fairmont, W. Va., six 150-kilowatt rotary converters, eighteen 55 kv-a. transformers, switchboard panels, and accessories; also a 10-ton and two 4-ton electric mining locomotives in its mines at Van Lear Junction, Ky., and a 7-ton locomotive in mine No. 120 at Acosta, Somerset County, Pa. The Pittsburg Coal Co., Pittsburg, Pa., three 50-horsepower, one 100-horsepower, and five 250-horsepower motors; two 30 kv-a. and three 75 kv-a. speed regulator sets; nine 20 kv-a. and three 30 kv-a. transformers, switchboard panels, and accessories. The Clinchfield Coal Corporation, Dante, Va., eight 5-ton and two 10-ton electric mining locomotives. The Sun Coal Co., Careyville, Tenn., a 375 kv-a. Curtis turbogenerator with 14-kilowatt exciter, one 150-kilowatt motor-generator set, switchboard, and accessories, and two 8-ton electric mining locomotives. The Thomas Coal Co., McComas, W. Va., for power station at Mora, W. Va., 100-kilowatt and 200-kilowatt rotary converters and switchboards. The Crystal Coal and Coke Co., Crystal, W. Va., for station at Mora, W. Va., a 300-kilowatt rotary converter and switchboard. The Spring Cañon Coal Co., Provo, Utah, for mines at Helper, Utah, 6-ton and 15-ton, 40-inch gauge electric mining locomotives and a switchboard.

Kewanee Unions.—The National Tube Co. have just issued the fourth edition of their popular booklet, "The Whole Kewanee Family," which contains a little history of the Kewanee Union principle, its advantages, various fittings made with the principle, including Kewanee union in various styles as Kewanee air-drill unions, Kewanee hose unions, Kewanee air-pump unions, etc. The popularity of the union is easily understood when it is remembered that the connection is brass to iron thread, meaning no corrosion, brass to iron ball joint seat, hence no gasket, solid, three-piece construction with no inserted parts, and that it is easily disconnected, no force being required.

The "Fulton" pocket target is a handy and useful article for locating or sighting the line from which the plumb-bob is suspended over a given point. It is made of white celluloid, circular in form with a diamond-shaped cut in the center which offers a strong contrast against the white body of the target and through which the plumb-bob line is easily sighted from the instrument at very long distances. It is convenient to carry in the pocket, readily attached or detached by means of the slots and can be raised or lowered at will. It will be appreciated when sighting in dark or shady places or toward dusk when the light is failing. In such cases a lighted match held behind the cut-out will enable the transit man to quickly locate the line. It is useful in crowded city streets where the operator can, without any effort, hold the target over the heads of passing pedestrians who are liable to obstruct the view. It is also serviceable in the country where sights are constantly taken with shrubs or foliage as a background, making the plumb-bob line indiscernible at long distances. Possibly it will be found more convenient and more accurate than a flag or sighting pole with its accompanying "waving of the pole" to set same plumb. The device is sold by Kolesch & Co., of New York.

New Coal Cleaning Plants.—The Long Flame Coal Co., at Stow, Logan County, W. Va., is beginning operation of its new equipment erected by the Fairmont Mining Machinery Co., Fairmont, W. Va. The mine is in the famous Island Creek seam, and is a good gas coal. The output will be 2,000 tons per day when the mine is developed. Equipment consists of a rope-and-button type retarding conveyer, 250 feet long, on 37-per-cent. grade, which delivers coal to a 6-foot picking band before passing over shaker screens. Four sizes of coal can be prepared or shipped as run of mine. The Fairmont Company has also installed a bin and screening equipment for The Allegheny River Mining Co., which has started its new operation near Kittanning, Pa. The output will eventually be 4,000 tons per day. Coal is dumped over two dumps into adjustable drop baskets which deliver into storage bin with least breakage. A retarding conveyer takes the coal in steady stream from bin delivering it to a gravity bar screen over railroad tracks. Larger sizes load directly to cars while smaller sizes are passed over a shaker screen and further separated.

Catalogs Received

The Roessler & Hasslacher Chemical Co., 100 William St., New York. Price list.

J. A. Brennan Drilling Co., 304 Peoples Bank Bldg., Scranton, Pa. Circular, "You Can't Look Into the Earth."

Ingersoll-Rand Co., 414 Arcade Bldg., Philadelphia, Pa. Circular, The Butterfly Jackhammer.

Sullivan Machinery Co., 122 S. Michigan Ave., Chicago, Ill. Sullivan Air Compressors, 32 pages; Sullivan Cross-Compound Power-Driven Air Compressors, 19 pages; Sullivan Hammer Drills for Quarry Purposes; and Stone Dressing Tools, 19 pages.

The T. L. Smith Co., Milwaukee, Wis. Catalog No. 252, Rock, Ore, and Gravel Handling Machinery, 39 pages.

The Goulds Mfg. Co., Seneca Falls, N. Y. Rotary Pumps, 16 pages.

Jeffrey Mfg. Co., Columbus, Ohio. Jeffrey Mine Fans, 36 pages.

Armstrong Cork Co., Pittsburg, Pa. The Insulation of Underground Steam Lines, 32 pages.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. "Chicago Pneumatic" Class L-SS and L-SB Compressors, 7 pages; "Chicago Pneumatic" Power Driven Compressors, 29 pages; Duntley Electric Grinders, 7 pages; Catalog No. 43, "Rockford Railway Motor Cars," 27 pages.

The Colliery Engineer

Formerly Mines and Minerals

XXXIV—No. 3 OCTOBER, 1913 Scranton, Pa.

Classified List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68

OCT 4 1913

UNIVERSITY OF TORONTO

The Underground Dentist

"SURE GRIP"

"Sure Grip" is not simply a trade name used to designate our particular brand of Trolley Clamps. It is also an absolute guarantee—it's a fact.

The "Sure Grip" Trolley Clamp is all its name implies.

It is so constructed that, once adjusted properly, it is simply impossible for it to work loose or to drop the wire.

This is but one of the features that has made the "Sure Grip" Trolley Clamps so popular in the mine field. Men in the workings feel absolutely secure when walking along passages where trolley wire is strung. They know that the wire **cannot** work loose and hang down, endangering their lives.

Made in all sizes from 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine and Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah Cleveland
(Office Atlanta)
San Francisco Los Angeles
Seattle Portland, Ore.

COPYRIGHT, 1913, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

For Anthracite Mines and Bituminous Minerals

Vol. XXXIV—No. 3 OCTOBER, 1913 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1851

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

CIRCULATION THIS NUMBER 13,000

TABLE OF CONTENTS

Editorial—
First-Aid Contests—American Mining Congress—Correction—Our Supplement—Our Cover Picture—Wanton Destruction of a Large Mexican Coal Mine—What the Large Anthracite Companies Have Done. 131
Personals 134
Industrial Welfare and Efficiency Conference 134
Rope Haulage at Vesta No. 4 Mine, by Wm. Z. Price 135
Animal Haulage, by Beverly S. Randolph 139
Compressed Air in Mine Haulage, by Wm. Z. Price 142
The Prevention of Overwinding 145
The Storage Battery Locomotive, by Arvid R. Anderson 146
Mining Plant of Petros Coal Co., by A. W. Evans 151
Mine Tracks 152
Gasoline Mine Locomotives, by Carl Scholz 153
Frogless Switch 154
Slope Haulage at Sayreton, Ala., by F. G. Morris 155
Reminiscences of the Schuylkill Region 156
Field Test of the Electric Locomotive, by Leonard V. Newton 157
Cost of Mining as Related to Output, by R. C. Jones 158
Safety Gates for Shafts 162
Gasoline Motors in Coal Mines, by A. J. King 164
Practical Mule Haulage, by A. E. Thompson 166
The Leasing of Mineral Lands, by William Griffith 167
The Protection of Pit Ponies 169
Prevention of Haulage Accidents 169
Book Review 170
Explosives 170
Haulage, by the Manufacturers—
Efficiency in Mine Haulage, 171—Advantages of Steel Mine Cars, 172—Hyatt Roller Bearings Applied to Mine Cars, 173—Wire Rope Haulage, 173—Rope Haulage Systems, 174—Signaling in Gassy Mines, 175—Mine Car Construction, 175—The Fairmont Endless Cable Car Haul 176
Producer Gas Engines in a New Field 178
Prize Contest 177
The Letter Box—
Compound Interest by Logarithms—A Defense of the Carbide Lamp—Acetylene Lamps—The Oklahoma Undercutting Law Repealed—Underground Rubbish Car—What Is Dynamite Anyhow? 179
Practical Talks on Coal Mining—
Electricity in Mines, 182—Mechanics of Mining, 184—Mine Ventilation 186
Answers to Examination Questions 189
New Wrinkle in Coal Cutting 192
National Conservation Congress 192
New Mining Machinery—
Graphite Lubrication, 193—Ventura Fans 194
Trade Notices 194
Catalogs Received 196
Pennsylvania Notes 196
Squibs—
Ice, 138—Oneida Drainage Tunnel, 142—An Efficient Sprayer in Northumbria, 145—International Engineering Congress, 150—U. S. Geological Survey Coal Maps, 153—Mule Steam Bath, 156—Power Used in Anthracite Mines, 161—Preservation of Ties, 163—Coal Saved by By-Product Ovens, 181—Planting Sand Dunes, 188—Mules, 192—Eckley First-Aid Team 192

First-Aid Contests

THIS being the season of yearly first-aid contests considerable space will be devoted to them in the November issue of THE COLLIERY ENGINEER, as has been the custom heretofore. This journal goes to press for October on the 15th of September which prohibits recording the numerous events which occur in September until the November issue, and then they are all there.

American Mining Congress

THE official calls have been issued, and by the time our readers receive this issue the American Mining Congress will have about finished all arrangements for the big convention in Philadelphia, Pa., that begins October 20. The headquarters will be the Bellevue-Stratford Hotel on Broad Street. This street is found by turning to your right. The mining machinery exhibition will be held at Horticultural Hall, located one block from the hotel.

Correction

THE statement by a special correspondent, in our last issue that John Lochrie, of Windber, Pa., in conjunction with some proposed operations in the Cambria-Somerset, Pa., field, had purchased the Eureka No. 36 mine from the Berwind-White Coal Co. was incorrect. Eureka No. 36 is one of the largest and most productive of the Berwind-White mines, producing nearly 700,000 tons per annum.

Our Supplement

THE COLLIERY ENGINEER'S supplement to this issue gives the columnar sections of the various coal beds in the anthracite fields of Northeastern Pennsylvania. Heretofore with the meager data at hand, it has been an unsatisfactory undertaking to correlate the coal beds, owing to the variation in number, as well as in thickness and physical structure, of the same beds in the different fields. It is believed, therefore, that this chart will be appreciated by engineers and mine officials, to whom it is of special interest, and by those engaged in the commercial end of the anthracite industry, to whom it is of general interest.

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

Our Cover Picture

A FRIEND sent us the photograph on the front cover a long time ago, remarking that as it was an unusual one it might prove interesting. Haulage machinery is generally repaired on the surface, but since electric lights are used underground the expense incurred in the transposition has become negligible, at least the photograph suggests that to be the case.

Wanton Destruction of a Large Mexican Coal Mine

ON August 16 the entire Lampacitos plant of the Compania Carbonifera Agujita y Anexas, in the state of Coahuila, Mexico, was destroyed by the Carranza forces in making their retreat northward from Hermanos, where they were badly defeated by the Federals.

That the destruction was premeditated was evidenced by the fact that the destruction commenced as soon as word came from Hermanos that the fight there had been lost.

The Carranza soldiers used dynamite and gasoline and within 2 hours they created a loss of fully $1,000,000

The washery was completely destroyed as well as the warehouse containing upwards of $40,000 worth of supplies. In the power plant the 200-kilowatt, 150-kilowatt, 100-kilowatt, and 30-kilowatt generating units were first blown to pieces with dynamite and then the building was burned. At the mines, the tipples were burned and the fireproof fans and fan houses were destroyed with dynamite. All of the electric and steam hoists at the mines were destroyed with dynamite, and the houses burned. A large number of the employes' and miners' houses were burned, including the residence of the superintendent with all its contents. Through the wanton destruction of machinery, the mines will soon fill with water, thus materially increasing the loss. The same company's plant at Agujita has been threatened with similar treatment unless $50,000 is paid for "protection." They have already at the time of our correspondent's writing, August 25, taken from the Agujita plant all the supplies and furniture. The wanton destruction of this American property cannot be excused as a military necessity, though the Carranzistas claim they destroyed it in order to prevent the Federals getting coal to operate trains, etc.

The Mexican problem is a hard one to solve, and it is up to the United States Government to solve it. The solution will only be obtained by the elimination of Huerta and the various rebel chieftans from Mexican politics, a free and untrammeled election of a government representing the whole people, and the assurance from the United States, that unless order is maintained and the rights of Americans and other law-abiding foreigners in Mexico are respected, summary punishment will follow.

If Mexico is to be guaranteed freedom from interference in her government by European nations, under the "Monroe Doctrine," the United States is morally bound to see that the Mexicans behave themselves.

What the Large Anthracite Companies Have Done

IN 1912 there were 144,455 tons of anthracite coal mined, in Pennsylvania, per fatal accident, as against 116,776 tons in 1901, 107,196 tons in 1892, 115,501 tons in 1882, and 85,835 tons in 1872. In attempting to compile these figures by decades the statistics for 1901 were used instead of those of 1902 because the long strike in the latter year, with the consequent less work done and less coal mined, made the use of the statistics for that year less reliable for purposes of comparison.

Expressed in another way, in 1912 there was 23.7 per cent. more coal mined per fatality than in 1901; 34.75 per cent. more than in 1892; 25.1 per cent. more than in 1882, and 68.25 per cent. more than in 1872.

These figures show a great and continuous improvement for the past four decades. When it is remembered that in each succeeding decade the dangers incident to the industry have increased, through more extensive mining, the working of deeper coal, the increased use of machinery, and the radical change from all English mine workers to a majority of the mine workers being from non-English speaking nations, the improvement is much greater than the figures show.

If, in 1872, the anthracite mines had been worked as they now are, with the same class of labor as was then employed, the production per fatality instead of being so much less, would undoubtedly have been much more than it was in 1912.

One reason for the improvement shown is the strict observance of rational mine laws, enforced by direction of able State Mine Inspectors, and the almost universal cooperation of the mine officials with the inspectors.

Rational laws and careful inspection, however, are not the only reasons for this great improvement. It is due as much to the working policies of the large anthracite companies as it is to state laws and state inspection. As a rule, the precautions taken in the mines of the large companies, and the means provided to secure greatest safety and most sanitary conditions, are fully up to the law's requirements, and in many instances better.

In 1872, most of the anthracite coal was mined by individual operators. With few exceptions, the corporations engaged in the industry were of comparatively limited capital, and size. They, instead of leading in reforms, merely kept in step with the individual operators who were their competitors in the market. Both classes required of their mine officials the production of the most coal at the least expense, regardless of waste, and with but little regard to the health and safety of the mine workers. This was the condition at the mines when there was enough market demand to absorb the output.

When the demand was supplied, and there was no market for anthracite at any price, or even a small demand at very low prices, the mines either shut down and suffered more or less deterioration in all features, including the few safeguards, or such coal as could be mined at least cost was taken out, with but little regard for the future of the coal property or the lives of the mine workers.

These conditions were not due to the lack of appreciation of the value of human life on the part of the mine owners and mine officials. They were due to lack of technical knowledge on the part of mine officials, and business conditions caused by intense competition in the market, due to urgent financial needs of some of the mine owners, who were frequently on the verge of ruin, or to piratical actions of others who were after the business scalp of a weaker brother. The business of mining anthracite coal, under such conditions, was a precarious one, and many of the individual operators experienced alternate periods of affluence and penury, until they were compelled to quit, with the loss of almost all, if not all of their money. Of course there were exceptions in the case of operators who had superior natural conditions at their mines, or who had capital enough to weather all financial storms. In course of time, owing to the acquired ownership of large acreages of coal lands, and the failure of some of the operators and retirement of others when their leases expired, the large companies began operating the collieries themselves.

Forty years ago the Lehigh Coal and Navigation Co., the Pennsylvania Coal Co., and the Delaware & Hudson Co. were the only large companies extensively engaged in mining, and the extent of their mining operations as compared with those of today was limited.

With the advent of the other large companies in the business and the growth of the industry, improvements began in all regions. Progress was slow at first, and there were times when some of the companies were on the verge of bankruptcy. Finally, technical skill, and the expenditure of large sums of money had their effect. Improvements in the condition of the mines as regards safety were made, the business was placed on a sound basis, and for the past 15 or 20 years the anthracite regions have, with but few short periods of depression, been very prosperous. This does not mean that for that period the companies owning and operating the mines have been uniformly prosperous. It means that the mine workers and the business and professional men of the region have been generally prosperous.

A brief summary of some of the benefits the large companies have given the region and the country at large, is as follows:

At considerable cost and the employment of the best technical talent, they have revolutionized the details of mining and preparing coal, whereby the mines, naturally more dangerous than in the past, have been made safer than ever before. By the use of large capital in development work, and in providing machinery, they are conserving the valuable anthracite deposits by extracting from the ground, and making available for use, from 50 to 100 per cent. more of the coal in a given area, than was extracted 40 or even 30 years ago. In this, they are mining seams that even 20 years ago were considered too small to be profitably worked.

They have abolished "pluck-me stores" in which most mine workers under old conditions were compelled to take out practically all of their wages in goods at high prices. They pay their mine workers in cash, and do not attempt to influence them to buy at any particular store.

They support liberally and consistently every practical suggestion of the State Mining Department and the United States Bureau of Mines tending to increase the safety of the mine workers, and have originated more improvements than either.

They have organized and equipped first-aid and rescue corps that are models of efficiency, and they have liberally contributed to hospitals and other philanthropic institutions of benefit to mine workers.

They have contributed liberally to educational work among the mine workers, thus increasing their efficiency and their value as intelligent citizens.

They are placing in the markets a regular supply of anthracite at prices that yield a fair profit only, notwithstanding that for years they lost vast sums on mining, which have never been, nor never will be, made up.

They have by fair treatment and consideration for their employes secured the good-will of all their most intelligent mine workers, so that even in times of labor disputes, when the officials are on one side, and the mine workers on the other, the only hostility shown comes from the most ignorant or most irresponsible men.

As the individual operators did, they sell the retail coal dealers of the various cities and towns outside of the region 2,240 pounds of coal for a ton. The retailer, after adding a liberal profit on the basis of the same ton, usually gives his customer but 2,000 pounds for a ton, and in some cases weighs the driver in as well. Often the companies are blamed for these methods of the retailers.

United States officials at Washington, inspired by yellow journals, muck raking magazine writers, and demagogues, are trying by actions at law to change these conditions, and restore those of the early seventies. If, instead of sending incompetent non-technical assistants into the anthracite regions and markets instructed to get evidence *against* the methods of the large companies, they would send men competent to investigate technically in both mining and selling, and instruct them to get all the truthful evidence favorable, as well as unfavorable, to the companies, considerable damage to a great industry and hundreds of thousands of working people and business men would be prevented.

There are hundreds of old English, Irish, and Welsh miners living in the region, any one of whom will emphatically declare that conditions today are infinitely better than they were even 20 years ago, and that to disrupt present conditions, and return to the conditions of the seventies will be a calamity.

PERSONALS

A. D. Miles, of Toronto, Canada, has been elected President of the Canadian Copper Co., Copper Cliff, Ontario, Canada.

Prof. Lewis E. Young, who for the past 6 years has been Director of the Missouri School of Mines, in September took up graduate work in the Department of Economics at the University of Illinois, and will also give part of his time to teaching in the Department of Mining Engineering.

William Clifford, of Jeanette, Pa., is visiting in the vicinity of his boyhood home near Haddon Hall, England, and has promised to write of early bituminous coal mining in Pennsylvania.

F. Julius Fohs is to have charge of the Mid-Continent office just opened by the firm of Fohs & Gardner, of Lexington, Ky., at 212, 213 Clinton Bldg., Tulsa, Okla., to care for their growing practice in the oil fields of the Central West. Mr. Gardner, who has just returned from a coal investigation in New Mexico, will remain in charge of their eastern office. This firm devotes its efforts almost wholly to coal and petroleum property investigations.

Thomas Harvey, superintendent of the Sugarite, New Mexico, mines of the St. Louis, Rocky Mountain and Pacific Co., resigned his position to become mine inspector for the Utah Fuel Co., at Sunnyside, Utah. Mr. Harvey is succeeded by W. Bert Lloyd, of Trinidad, Colo.

John Laing, Chief of the West Virginia Department of Mines, resigned that position, effective September 1. Mr. Laing retires in order to devote his attention to mining enterprises with which he is connected. He has been succeeded by E. A. Henry, a district inspector.

Governor Clarke, of Iowa, has appointed William Holland to succeed John E. Jeffreys as State Mine Inspector. Mr. Jeffreys recently resigned to accept a position as superintendent of the Consolidated Coal Co.'s mine at Buxton.

A. Kauffman, formerly assistant to the president of the Link-Belt Co., has been made General Manager of the Philadelphia Works at Nicetown, Philadelphia.

Elmer A. Holbrook, Professor of Mining Engineering in the Nova Scotia Technical College, Halifax, Nova Scotia, has been appointed Assistant Professor of Mining Engineering at the University of Illinois to have charge of the recently equipped coal-washing and ore-dressing laboratory and the course in mine design.

Frank B. Rutter, who, with his wife, was instantly killed in the disaster on the New York, New Haven & Hartford Railroad, on September 2, was a young man of exceptionally high attributes, and filled the important position of Vice-President and General Sales Agent of the Scranton Bolt and Nut Co. Mrs. Rutter was an accomplished young woman of attractive personal appearance, and was noted for her amiability and charm of manner. She was the only daughter of A. F. Law, President of the several coal companies that formerly constituted the Temple Iron Co. The sympathy of all Mr. Law's colleagues in the industry, and hosts of personal friends is with him and Mrs. Law in their sudden and double bereavement.

Robt. F. Roth, transitman for The Philadelphia & Reading Coal and Iron Co., at Mahanoy City, Pa., has accepted the position as engineer in charge of E. E. White Coal Co. operations at Glen White, W. Va.

R. J. Gould, of Berlin, Pa., has joined the engineering corps of John Lochrie, at Scalp Level, Pa., and will assist Mr. Frailey.

At the dinner given in honor of Oberbergrat Dr. Richard Beck, Rektor of the Freiberg Bergakademie, Freiberg, Saxony, Germany, on Tuesday, September 9, 1913, at the Engineer's Club, 32 West Fortieth Street, New York, the following members were present: Dr. Richard Beck, Freiberg, Saxony, Germany; Franklin B. Guiterman, T. Waln Morgan Draper, Dr. P. J. Oettinger, Dr. R. W. Raymond, Baron Alfred von der Ropp, H. H. Knox, G. M. Godley, H. A. J. Wilkens, and H. H. Webb, of New York City; Albert Meyer, Irvington, N. J.; R. M. Payne, Perth Amboy, N. J.; Gardner F. Williams and Dr. Arnold Hague, Washington, D. C.; O. G. Shultz, Morristown, N. J.; Dr. F. A. Wilder, North Holston, Va.; Dr. William B. Phillips, Austin, Tex.; Prof. Waldemar Lindgren, Boston, Mass.; and Charles L. Bryden, Scranton, Pa.

E. E. White, of Glen White, W. Va., Vice-President of the Smokeless Coal Operators Association, of West Virginia, was a guest at the Susquehanna Coal Co.'s first-aid meet at Edgewood Park, near Shamokin.

Industrial Welfare and Efficiency Conference

Mr. George S. Comstock, President of the Engineers Society of Pennsylvania, at Harrisburg, has issued a call for a Pennsylvania Industrial Welfare and Efficiency Conference to be held at Harrisburg, Pa., October 28-30, inclusive.

The Pennsylvania State Service Session, October 28, will discuss Vocational Education, Good Highways, Vocational Diseases, Water Conservation, Fire Prevention, Safety and Health in Mines.

October 29 will be devoted to conditions of labor, including Labor Compensation, Arbitration, Cooperative Methods, State Employment Agencies, Child Labor, Woman Labor, the Immigrant Problem, Sanitation, Heat, Light, and Ventilation, and Statistics to Aid Industries and Prevent Accidents.

On October 30, the conference will discuss Boiler Inspection, Mill Safeguards, Safety Organization, Inspection Maintenance, Foundry Accidents, Fire Prevention and Drills, and Especial Hazards in the Metal and Textile Industries.

The Colliery Engineer

COAL MINING & PREPARATION

Rope Haulage at Vesta No. 4 Mine

System Operated by the Vesta Coal Co., California, Pa., Having a Capacity of 6,000 Tons Per Day

By William Z. Price

WHAT is probably the greatest system of mechanical haulage in the coal mining world is in operation at the Vesta No. 4 mine of the Vesta Coal Company, at California, Pennsylvania, on the west bank of the Monongahela River about 50 miles southeast of Pittsburg on the Monongahela Division of the Pennsylvania Railroad. Although the drift mouth is 2½ miles west of the tipple at the river, and the main turnout or parting 2 miles farther on inside the mine, yet Mr. R. B. Drum, general manager of the company, has originated and put into operation a system of rope haulage that is incomparable from the point of efficiency and cost of maintenance.

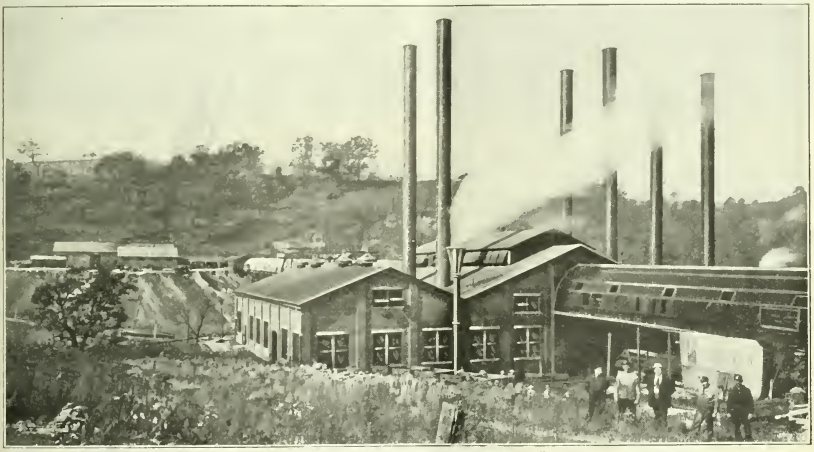


FIG 1 POWER HOUSE AND HAULAGE ROAD. DRIFT MOUTH IN DISTANCE

The tipple, which is built to load river craft only, is constructed of massive concrete and cut sandstone masonry, which supplant the commonly used wooden piling for foundations; and steel made by the Jones & Laughlin Steel Company, of Pittsburg, is exclusively used in the superstructure. The tipple floor consists of heavy steel sheets with 4-inch oak planking under the tracks. The main part of the tipple is 60 feet wide and is built on a deflection of about 45 degrees from the course of the approach, making it at right angles to the railroad and the river.

The mine itself covers a vast area and is being operated at the tremendous rate of over 6,000 tons of coal per day; and this, with an average seam thickness of 6 feet 8 inches, means the mining out of nearly 4 acres a week. The record production to date, for an 8-hour day is 7,235 tons. When the loaded trip arrives at the tipple, the cars are picked up one by one by a chain haul about 35 feet long driven by a 110-horsepower Westinghouse motor and constructed to handle a trip of 150 cars. This haul moves the cars up a slight grade to a Fairbanks scale at the rate of four to six cars a minute. From the scale they drop by gravity to a Phillips cross-over dump. Two dumps have been constructed side by side, but as one

dump has been able up to the present time to handle the largest run, by maintaining, without congestion, a constant speed of from 12 to 18 tons per minute, it has never been found necessary to operate both dumps simultaneously. Both dumps use the same kick-back which returns the cars to a single empty track to the left of the dump.

The trips, averaging 120 to 125 cars each, are landed on the side thack at the same time the empty trip arrives from the tipple; the head and tail ropes of the two trips are then exchanged and the loaded cars and the empty trip proceed on their journey. It will be noted, however, that the ingoing empty trip has no tail rope, it having been dropped about a mile back; this will be explained in the following description of the outside haulage road.

for should there be a head rope going down the grade on the return to the tipple, and the tail rope break, a disastrous wreck would follow, for it is evident the head line would become caught under the runaway cars.

The haulage road from the tipple first crosses a trestle, shown in Fig. 2, built exclusively of steel with the exception of the 4-inch oak plank floor. The steel work is supported by concrete piers. The trestle floor is absolutely level and straight, leaving the tipple on a course of S 45° W and extending for 2,900 feet up the valley of Pike Run at an average height of 50 feet. The tracks are laid on a 4-foot gauge. The first 1,200 feet along the trestle is double-tracked, with a 4-foot space between the tracks, and there the trestle is 24 feet wide. The remaining distance is single-tracked and 16 feet wide. The entire trestle is arched with steel and can be covered if it ever becomes advisable. Incandescent lamps at intervals of about 15 feet light the double track when necessary. From the end of the trestle the haulage road continues level and in the same direction for a distance of 700 feet on the ground and then curves to the right by means of a 100-foot radius curve to N 78° W and continues level on this course through a tunnel 425 feet long, Fig. 3, and across a steel bridge spanning Pike Run to the long tunnel, which is 10 feet wide and 9 feet high. The

Fig. 2. Empty Cars on Way to the Mine

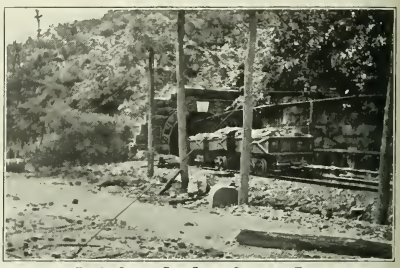


Fig. 3. Loaded Cars Coming Out of the Tunnel

The empty cars are there stopped by a friction car check acting on the rims of the wheels, and, by means of a chain hoist driven by a 20-horsepower Westinghouse motor, are elevated, one at a time, to a sufficient height to run by gravity to the haulage road on the trestle.

The turnout, or side track as it is locally known, begins about 200 feet inside the drift mouth and extends inside for 1,500 feet. In connection with this side track it may be said that this is one of the few mines in the country, if not the only one, where two trips are landed on the same side track at the same time, using, of course, this system of head and tail ropes.

The loaded cars are hauled from the various entries by electric locomotives to the inside main turnout or parting. This parting is approximately 1,300 feet long and is located about 2 miles inside the side track. The grade of the haulage road from the parting of the side track is 1.8 per cent. against the loaded cars. The head rope used is a 1⅛-inch steel wire cable and the tail rope is 1 inch in diameter.

The grade of the outside haulage road, that is, from the side track to the tipple, is from 2½ to 2 per cent. in favor of the loaded trip for a distance of about a mile, where it becomes level and continues so to the tipple. When the empty cars come to the point where the grade begins, the tail rope is detached and the head line draws the trip to the side track. This rope is there transferred to the tail end of the loaded trip, which is started by a 14-ton electric locomotive coupled on the head end. The locomotive acquires a fair speed by the time the drift mouth is reached and then is side-tracked and the loaded cars coast down the grade dragging the tail rope. At the point where the other rope was detached it is now coupled on the head end of the trip, which then proceeds to the tipple. All this is done without stopping the trip an instant. The reason for dropping the tail rope of the empty trip is due to the grade,

bridge here mentioned is a single span truss on solid masonry foundations, and like the trestle is built entirely of steel with the exception of the 4-inch plank floor.

The long tunnel is driven N 78° W through the hill and is 4,100 feet long. The haulage road continues on exactly the same elevation as it had on leaving the tipple until a point is reached 740 feet inside the long tunnel from the bridge; from there the road follows a rise of 2 per cent. to the side track. From the western end of the tunnel a steel trestle 990 feet long crosses Pike Run. This trestle is double-tracked and on a 2 per cent. grade, crossing the run 90 feet above it and passing through the upper part of the haulage-engine and boiler rooms of the power house, Fig. 1. The trestle is arched with steel and covered with weather boarding and granite roofing; about 50 feet from its western end is the drift mouth.

The cars used are made of steel with a plank bottom by the Watt Mining Car Wheel Company. The wheels are made by the Phillips Mine and Mill Supply Company. The cars weigh from 2,950 to 3,250 pounds and are loaded to hold 3 tons. The Watt cars differ from others in that they have spring draw-heads, which admit of greater ease and stability in handling. The doors are "rabbit-trap" style with an iron hook at the top. A stout chain with an iron rung 6 inches in diameter is suspended over the front of the dump. As the car is tilted forward, the rung engages the hook and opens the door, which drops back into place when the car resumes a horizontal position.

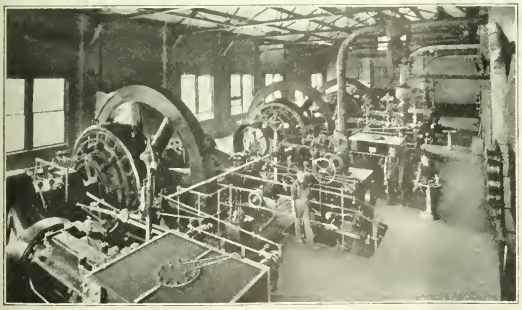


Fig. 4. Dynamos in the Power House

Some idea of the extent of the mine can be imagined when it is realized that there are 133 miles of underground track in use. Four sizes of rails are used; 16 pounds for the rooms, 30 pounds for the butt entries, 50 pounds for face entries, and 90 pounds for the main haulage, which, including the two rope haulage roads, aggregates 12 miles.

The power plant, Fig. 1, occupies a unique position with regard to the haulage road. The building is unquestionably one of the finest mine power plants in the country. With its 13-inch brick walls, concrete and stone foundations, steel roof trusses and slate roofing, it is as substantial and fireproof as a building of the kind could be made. It is about 110 feet long in the direction of the trestle and 130 feet in the other direction.

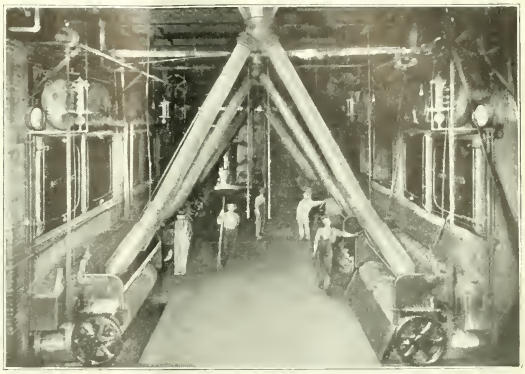


Fig. 5. Boiler Room of Power House

The dynamo room, Fig. 4, extends across the south end of the power house and is 42 ft. × 100 ft. In this room are three exactly similar cross-compound Corliss engines, made by the C. & G. Cooper Company, of Mt. Vernon, Ohio, set side by side, each directly connected to a 500-kilowatt, 550-volt Westinghouse direct-current generator. The switchboard is so arranged as to run the generators singly or all together.

The system of oiling the engines and dynamos is worthy of mention, it being decidedly efficient and economical. It is a gravity oiling system installed by the Pittsburg Gage and Supply Company. The oil is piped to each oil cup from a tank near the roof, and after it has been used it is piped by gravity to a White

Star oil filter and purifier in the boiler house. After being filtered the oil is pumped back to the tank by a small Canton pump. One barrel of oil runs the three larger engines and dynamos a month.

The rope-haulage engines are of two sizes. Since the inside rope haulage road has the grade against the loaded cars, it requires a more powerful set of engines than that to the tipple, where the grade is with the loaded trip most of the way.

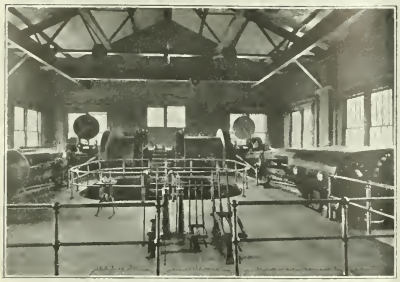


Fig. 6. Engines for Inside Haulage Road

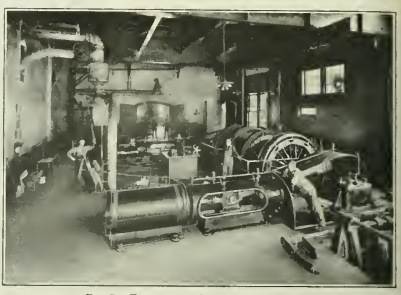


Fig. 7. Engines for Outside Haulage Road

The engines for the inside rope haulage, Fig. 6, which transports the coal from the parting to the side track, a distance of 2 miles, are 42″ × 60″ cross-compound engines made by the Vulcan Iron Works, of Wilkes-Barre, Pennsylvania. These engines have the brake, reverse, and friction clutch operated by steam. The drums differ in size owing to the two sizes of rope used. There are 13,000 feet of 1⅛-inch rope wound on the main drum, which is 6½ feet wide. There are 19,080 feet of 1-inch rope wound on the second drum, which is 5 feet wide. Both drums are 7 feet in diameter.

In an adjoining room are the engines for the outside rope haulage which are 24 in. × 48 in. made by J. & J. B. Milholland Company, Pittsburg, Fig. 7. The drums are 6 feet in diameter and 3½ feet wide. There are 19,050 feet of rope wound on one drum and 15,500 feet on the other, both 1-inch ropes. Attached to the engine is a recording gauge, made by the Young Recording Gage Company, of Connellsville, Pennsylvania, which shows the speed and location of the trips at all times, as well as delays, etc. A Schaeffer & Budenbarg tachometer is also attached, which shows the revolutions per minute of the drums. A standard form sheet is fastened about a rotating vertical cylinder, and is marked with red ink as the cylinder revolves. Any complaints as to the speed or laxity of the trip can be verified by referring to these records. The average time per round trip is 24 minutes. The haulage trestle connecting the drift mouth with the tunnel passes some distance above these engines but directly over them.

The boiler plant, Fig. 5, occupies the northeast section of the power house, and consists of six batteries of two boilers each, Babcock & Wilcox type. Each battery is rated at 300 horsepower. They consume 85 tons of crushed coal a day.

It will be noted that the steel arches on the trestle in Fig. 2 support wooden cross-pieces which hold in place an electric trolley wire. The reason is, should the rope haulage be disarranged in any way, electric locomotives can be impressed into service in hauling coal to the tipple.

As to the comparison of the cost of this rope haulage with that of electric locomotives for the same haul, the difference is so great that there is scarcely any comparison. For the amount of coal produced and the haul of almost 5 miles, it would be impossible to have enough electric locomotives to handle the coal, besides it would require double-tracking all the way and the wear and tear on track and cars would be enormous.

Many electric locomotives are used inside the mine for gathering and hauling to the parting. All told this immense coal mine utilizes 37 electric mine locomotives of various sizes, 5 of Jeffrey manufacture and the remainder made by the Baldwin-Westinghouse companies.

The head and tail ropes used are of Roebling manufacture, last about 2 years, and haul in that time approximately 3,000,000 tons.

The writer wishes to take this means of thanking the officials, Messrs. R. B. Drum, General Manager, and H. C. Drum, General Superintendent of the Vesta Coal Company, and Joseph E. Edwards, Superintendent of Vesta No. 4 Mine, for their courtesy and consideration in tendering every facility for the inspection and examination of this remarkably efficient plant.

Ice is solid water at 32° F. The relative volume of ice to water at 32° F. is 1.0855, the expansion of water when passing into the solid state being 8.55 per cent.

Animal Haulage in Mines

Selection of Animals Suited to the Work—The Type of Mule Which Experience Has Shown to be Most Economical

By Beverley S. Randolph*

While the steady development of mechanical haulage in and about mines during the last 30 years has supplanted animal haulage to a great extent, still there are a number of conditions in which the use of animals will be found economical for this purpose.

In gathering from a number of nearby working places a small locomotive, driven by compressed air or electricity, will usually be found most efficient up to the point where the grade so increases the resistance that the wheel adhesion to the rails is not sufficient to insure satisfactory progress. This occurs between a 5 per cent. and 10 per cent. grade, depending on the amount of moisture, the kind of rails, and other conditions affecting adhesion.

Beyond this track inclination, and up to 20 per cent. to 25 per cent., animals will be found more economical, especially if the working faces advance rapidly, since the following of any number of breasts with any form of rope or special adhesion haulage complicates the machinery and makes gathering more expensive than with animals. With a further increase in the rate of grade, animal haulage can usually be replaced to advantage with some form of gravity plane up to an angle where the material will slide on the floor of the room.

Fig. 1. Four Mules That Records of Three Years Showed Most Efficient

When the daily output is within the capacity of one animal, or of one team handled by a single driver, there is no cheaper form of haulage. When the second team becomes necessary, mechanical haulage will often be found more economical.

*Civil and Mining Engineer.

This leaves animal haulage more economical for small operations and for gathering in mines with fairly steep grades.

In the successful operation of animal haulage the first step is, naturally, the selection of the proper kind of animal. In mines where the low roof prevents the use of large animals, the mule appears to be the general favorite. In the high seams a considerable difference of opinion will be found among men of experience in such matters.

The experience and observation of the writer leads him to favor the mule under all conditions. The psychological character of the mule for the dull monotonous work of mine haulage, urges the animal to observe care and watchfulness regarding conditions in the average mine. The mule therefore lasts longer, an important item when the cost of training an animal to underground work is considered. Up to about 75 years ago, when the systematic production of draught horses in France, England, and Scotland may be said to have originated, the horse was valued and bred almost exclusively for military and racing purposes, cultivating a free, generous animal ready to do whatever was asked without regard to consequences. The horse still retains these characteristics. The ass, on the contrary, has always been valued for his ability to withstand long periods of dull, monotonous labor and general rough treatment, his success in this line depending more on his shrewd cunning in saving himself and taking the line of least resistance than in his strength. This character the mule inherits, therefore learns more readily the little tricks which save him from accidents, and at the same time accomplishes the work, for example, the meeting of any check in the velocity of the load with a prompt pull which carries the mass past the point of resistance before the momentum is lost, rather than allowing the load to stop and be started again with excessive effort. Last but not least, when exhausted he will stop, and no amount of punishment will induce him to go to the point of seriously injuring himself, therefore when given a chance he recovers and is again as good as ever. The horse, on the other hand, is readily driven to a point of exhaustion beyond which there is no recovery.

The writer is disposed to attribute the favor in which horses are frequently held, where it is not a matter of prejudice, to the difficulty of getting mules of sufficient size.

For general mine purposes an animal over 1,400 pounds, working weight, is too clumsy and sluggish to be efficient and is unable to stand the rapid traveling frequently demanded. By careful selection, mules but little under this weight can be obtained. It would seem an easy matter to select the large individuals from a lot of mules, but the experience of the writer is decidedly to the contrary. Some years ago when in charge of a large mining operation he gave his personal attention to this feature of the business and by means of careful measurements before purchasing was reasonably successful in his selections. He then undertook to delegate the work to a subordinate, selecting one with special knowledge and experience of horses and mules. This man seemed utterly unable to secure the necessary size and weight, and after two trials a second subordinate was sent with most happy results. The writer had been rather proud of his own ability in this line but was obliged to "take off his hat" to the last man, who continued to select most satisfactory animals for a number of years when, by reason of the merger of a number of enterprises, the purchasing fell into the hands of an expert who purchased several hundred animals yearly for all the included properties. Under this arrangement the old trouble appeared at once, the mules purchased were nearly all too light for the work after the "dealers fat" had been worked off. It is difficult to formulate an explanation for this, it being one of those psychological phenomena easier to state than to explain. It possibly arises from the inability to distinguish between an animal large in bone and muscle and one which is simply fat. The fact that all dealers insist on animals being fat before they are offered for sale would seem to strengthen this view.

The usual practice of the draught animal market is to specify height and weight, but it seems to the writer much better to follow the practice of the foreign-hunter market and specify girth and circumference of the cannon bone just under the knee. Just behind the elbow there is a minimum girth, which it sometimes takes two to three trials with the tape to obtain; this is practically independent of the flesh the animal carries and is also indicative of the heart and lung development. The circumference of the cannon bone is, of course, a fixed quantity, independent of the condition of the animal. A standard for each establishment can be fixed by measuring animals which have proved satisfactory and, under the comparative anatomist's law of "homologous parts" an animal which fills these measurements will rarely be found deficient elsewhere.

When it comes to the type of animal to be selected the authorities will generally advise a "close-coupled" animal with a short back. With this the writer is not disposed to agree, and believes it to be the survival of the days when all traveling was done on horseback and most freighting in pack saddles. Such an animal is undoubtedly the best weight carrier.

On the trotting turf, where the drastic test of actual measured performances eliminates anything like prejudice or preconceived opinions, the best performers almost invariably have long backs. Maud S, probably the greatest of them all, is described by her breeder as having the longest back and the longest

belly of any horse he ever saw. There is little difference between the energy developed in hauling a 200-pound man and a sulky a mile in two minutes and that developed in hauling 20,000 pounds of coal and cars three hundred feet in the same time.

While studying this feature some years ago the writer selected from each of four stables, working about twenty head each, the animal which, by a system of carefully kept accounts, had shown the greatest efficiency during the previous three years. These are shown in the accompanying Fig. 1, from which it will appear that all are what would be called rangy animals and two abnormally long.

Throughout the southern tier of counties in Pennsylvania there is a type of farm horse having an abnormally long body and short legs which is in high repute with the shrewd, thrifty farmers of that section. All this would indicate that there is no lack of nerve force and stamina in this type, as is frequently asserted, while as a mechanical proposition an animal of this shape is better adapted to exert its strength in a horizontal direction than a shorter animal.

In drawing a heavy load an animal does practically all the work with its hind quarters, the line of impulse being *A B*, Fig. 2, extending from the hind foot on the ground to the attachment of the trace at the collar. At *B*, this is resolved into one component in the line of the trace extended, and one vertical, which is met by the weight of the animal. While it is quite demonstrable that the ultimate horizontal resultant, as affecting the load, is the same whatever the angle of the trace, the vertical component *B E* of the resolution at *B*, is materially affected by this angle. In the case of a severe pull it is usually sufficient to lift the animal from his front feet. When this occurs the angle *B A G* begins to increase and the ability of the animal to exert a horizontal stress on the load has reached its maximum, though he may not yet be exerting anything like his full strength on the line *A B*. For this reason, the sharper the angle *A B C* the better opportunity the animal has to exert his strength on the load. This explains the fact that an animal can pull more with a weight on his back than without, also the not uncommon practice of

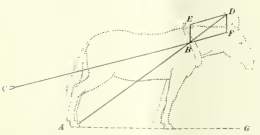


Fig. 2

veteran draught animals in getting down on the knees for a hard pull. With the long-bodied animal the line *A B* approaches more nearly the horizontal and is therefore more effective.

The standard to obtain the best results would therefore seem to be a long animal on short legs, having all the size and substance which the headroom of the mine will admit, up to a weight of about 1,400 pounds in working condition. Above this weight the size is abnormal and the animal rarely has the activity and capacity for working at speeds necessary to obtain best results.

Having obtained animals of the proper type, their management both in the stable and at work is naturally a matter of prime importance, but as this subject was quite fully treated in a previous paper in Mines and Minerals* it will not be discussed here. Its necessity in order that the animals may be at all times ready for efficient service needs no comment, while the value of maintaining the complement ready at all times may be illustrated by the following calculation:

Assuming the case of a mine where the output, when working its complement of 14 animals, is 980 tons per day, or 70 tons per animal, and assuming also the cost of production per ton above the mining rate at 25 cents, the daily expenditure on this account will be $245. If one animal is idle for a day from any cause the output for that day is reduced by 70 tons, becoming 910 tons. The expenses over and above the rate of mining are only reduced by the wages of the driver of the animal, who may be supposed to be idle. Allowing $2 for this, the expenditure for that day will remain $243, or 26.7 cents per ton, an increase of 1.7 cents per ton, or $15.47 on the 910 tons output. This therefore represents the loss due to the idleness of this one animal for the one day in question, but takes no account of loss due to the inability to fill orders or to take advantage of times when railroad cars are to be had in abundance.

The selection and management of the animals is naturally the feature of prime importance in any system of animal haulage as supplying the power, but the subject of diminishing the resistance to be overcome will well repay the closest scrutiny as it frequently becomes a serious expense.

The usual form of mine car with its short wheel base is not calculated to give a low resistance, and a longer wheel base would be desirable, but the short wheel base is a decided advantage on the sharp curves necessary in mine haulage and also makes it easier to replace a derailed car. It is easy to say that cars should be kept on the track, but it is quite difficult to accomplish this in practice. Cars may be derailed at places where it will affect the working of the entire mine and any delay in replacing them may cause serious loss.

Derailments can be decreased by seeing to it that all journals fit snugly in the wheels to maintain the flanges at full gauge, and that the journals are kept oiled and protected from dust and dirt.

The matter of grades and route of haulageways is one for special study in each case. The advantage of maintaining each at a minimum is so apparent that it would scarcely seem necessary to refer to it. Con-

*Vol 31, page 650.

trivances for reducing friction, such as practical roller bearings, come under this same head.

It is evident that where a number of trips are made daily the saving of a very few feet in the distance traveled on each trip amounts to a surprisingly long distance in the course of the day.

Lack of proper track surfacing and alignment is a fruitful source of resistance, and as these cannot be maintained in condition without proper drainage, the latter becomes an important matter.

The continual dropping of coal from the roof and sides of the haulageways and from the openings in the bottom of the cars, which coal is crushed under the wheels and the feet of passing men and animals, causes a great deal of fine dust and mud which must be continually removed if the best haulage results are to be obtained. The temptation to put off cleaning tracks "until some day when the mine is idle" has been the cause of untold wasted energy on the part of the animals.

All matters relating to haulage require detailed study at each operation and any lessening in the expenditure of animal energy will repay in efficiency the best efforts of the management.

A large output is nearly always an economical output and the efficiency of the haulage plant is the measure of the output. Where animals are used for gathering, no amount of efficiency in the mechanical end of the haulage plant will bring out more coal than the animals will gather, and the efficiency of the stable thus becomes the measure of the efficiency of the entire plant.

Oneida Drainage Tunnel

To drive the Oneida drainage tunnel for Coxe Bros. Co., near Nuremberg, Pa., required 9 days short of a year. It is 7 by 9 feet in section and 7,027 feet long. The average progress from both ends was 17¼ feet per day; the longest drive in any one month was 754 feet.

Compressed-Air Mine Haulage

Discussion of System—Method of Charging—Operation of Air Locomotives at Maple Hill Colliery

By William Z. Price

FOR THE underground transportation of coal, compressed air may be utilized either in driving locomotives or in operating stationary rope haulage engines. The former is the more widely used and hence of greater importance.

The essential parts comprised in the installation of a system of compressed-air haulage are the air compressors, pipe lines, charging stations, and locomotives. The capacity of the system naturally depends upon the size and character of the mine and the output desired. Formerly it was customary for mines worked through tunnels and drifts to omit the pipe line altogether, and to charge the locomotive at intervals from a large receiver outside, near the compressor.

At present, however, the pipe line is universally carried underground, and at various points charging stations are established, the location of these stations depending directly upon the length of haul and the capacity of the locomotive. It is evident that the last or innermost charging station must be at a point from which the locomotive can reach the end of its trip and return for a fresh supply of air.

When several locomotives are supplied by the same pipe line, as is often the case, it is rarely necessary to design the system for charging more than one at a time. The relatively slight drop in gauge pressure after charging is soon recovered by the compressor, which is kept in nearly constant operation. The piping in most plants is of the best material, with sleeve joints made with the utmost care to prevent leakage. The pipes should not be buried, but laid along the side of the haulage road, or fastened by brackets to the timber, so any slight leaks can be discovered and remedied.

The charging apparatus for the locomotives consists of a short right angle connection (Fig. 1) inserted in the air main by means of a heavy tee. This connection projects from the main a sufficient distance for conveniently coupling to the charging pipe of the locomotive. It consists of two parts: a vertical rigid branch, containing a strong accurately fitted 1½-inch gate valve and a short horizontal pipe, attached to the rigid upright by means of a ball and socket joint. This movable section is thus capable of being swung back out of the way when not in use. By an easily manipulated union it is coupled to the locomotive charging pipe. In the locomotive connection are two ball and socket joints together with a check-valve close to the tank. After coupling on the locomotive at the charging station, the gate valve is opened, whereupon the air pressure immediately forces together the parts of the ball and socket joints and makes a perfectly air-tight connection. As soon as equilibrium is established between the pressure in the air main and that in the locomotive tank, the valve is closed. To break the coupling, the compressed air remaining in the connection between the gate valve and the check-valve on the locomotive must first be released. This is done by opening a small "bleeder" valve, placed just above the gate valve. The joints then become loose and are easily manipulated. The charging requires from one to two minutes.

The compressed air locomotive, its operation, and construction, are similar to that of a steam locomotive, save that the bearings, etc., are much heavier. From the main storage tanks on the engine the air passes into a small auxiliary or distributing reservoir and thence to

the cylinders. By means of an automatic reducing valve the pressure in the small reservoir is adjusted to the requirement of the engine. As used on locomotives, the reducing valve consists of a double-seated balance valve operated by a small piston. The air pressure in the auxiliary reservoir acts on one side of this piston and tends to close the valve. This action is opposed by a strong external spring which is adjusted to keep the valve open until the normal working pressure is reached in the auxiliary reservoir. Then the valve is closed by the air pressure against the resistance of the spring. To provide for the case when the locomotive is using no air, as on down grade or at rest, a single seated supplementary valve controlled by the throttle is placed in the pipe between the locomotive storage tanks and the reducing valve.

Of late years the two-stage locomotive (Fig. 2) has come into prominence. This locomotive is a product of the H. K. Porter Company, who claim it to be vastly superior to the old style. In this locomotive the air is stored at a pressure of eight to nine hundred pounds, in the large cylindrical reservoir, which may be recharged in one to two minutes as previously explained. The air from this tank then passes through a regulating valve into the high-pressure cylinder at 250 pounds pressure and atmospheric temperature. From this cylinder it exhausts through an atmospheric inter-heater at a pressure of 50 pounds per square inch, to the low-pressure cylinder.

On account of the work done in the high-pressure cylinder, the temperature of the air leaving it is about 140 degrees Fahrenheit, below that of the atmosphere, rendering the surrounding air an efficient heating medium, which is readily utilized by means of the inter-heating cylindrical reservoir filled with small tubes through which the atmospheric air is rapidly drawn by the ejector action of the exhaust from the low-pressure cylinder. In this apparatus nearly all the heat lost in the high-pressure cylinder is restored, expanding the air about 36 per cent. and permitting higher initial and lower terminal pressures, with a wider range of expansion. These essential features of economical operation are yet impossible with the single-expansion locomotive, on account of the refrigeration.

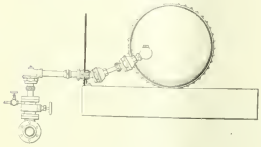


Fig. 1. Charging Device

The manufacturers claim that the increased efficiency obtained with this type of locomotive has resulted, under ordinary conditions, in reducing the cost of power about 30 per cent., reducing the size of the compressor 30 per cent., reducing the first cost of the complete installation approximately 15 per cent., and has increased by 30 per cent. the distance which the locomotive will travel on one change of air.

Haulage at Maple Hill Colliery

In all the anthracite region of Pennsylvania, and probably in all the state, there is no colliery of so great a tonnage depending entirely upon compressed-air haulage, as does the Maple Hill Colliery of the Philadelphia and Reading Coal and Iron Company, located midway between Shenandoah and Mahanoy City. This colliery is one of the largest producers in the anthracite field. Between 900 and 1,000 mine cars are hoisted up the two shafts each day and the average daily production of prepared sizes is 3,000 tons.

Some idea of the extent of this mammoth mine can be imagined when it is realized that it has 77 miles of underground track in operation, which is remarkable in view of the fact that the seams are on the pitch and the coal mined in the rooms is loaded from chutes.

There are 9 seams worked there, varying in thickness from 3 to 25 feet. The Primrose is the top seam and the Buck Mountain the bottom. Both the shafts, No. 1 and No. 2, which are only about 200 feet apart, are sunk near the axis of the basin, No. 1 shaft to the Top Split of the Mammoth and the other to the Buck Mountain. The basin runs east and west. The seams on the south dip average 18 degrees and those on the north dip vary from 18 to 40 degrees. A long tunnel a short distance east of the shafts, runs north and south from the Buck Mountain seam on one dip to the same seam on the other. This tunnel is 2,460 feet long, 1,050 feet north from No. 1 shaft and 1,410 feet south of it.

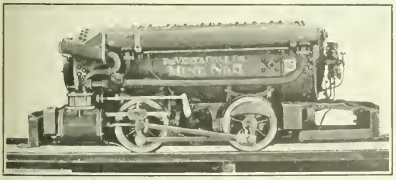


Fig. 2. Two-Stage, H. K. Porter Co., Air Locomotive

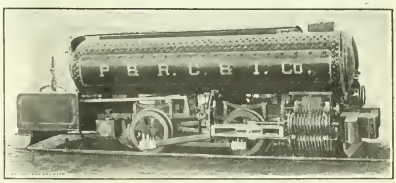


Fig. 3. Baldwin Air Locomotive at Maple Hill

The haulage roads are kept in excellent condition; the radius of the sharpest curve is 30 feet. Twenty-five pound rails are used where the mules haul cars from some of the entries to main turnouts, and 40-pound rails are used on the main haulage roads.

The mining of coal is divided into four separate divisions or districts, that on No. 2 shaft level, No. 1 shaft level and adjoining planes, No. 7 plane, and the Bore Hole slope. The coal from the last three named, which is about 600 cars a day, goes up No. 1 shaft.

Including the return trips for one trip to each section, the haulage distance for the motors on No. 1 shaft level is 65,100 feet, on No. 7 plane, 30,000 feet, on the Bore Hole slope level it is 21,000 feet, and on No. 2 shaft level about 42,000 feet. In No. 2 shaft workings no mules are used and most of the present work is driving gangways and airways, and it means a long distance for the locomotive to travel to collect comparatively few cars.

The compressed air plant at Maple Hill consists of two Norwalk three-stage compressors, one Allison and Bannon single-stage, and an Ingersoll single-stage compressor. The two single-stage compressors produce power for the empty car hoists in the two shafts, drill presses, small pumps, blacksmith forges, etc.

The two Norwalk compressors have steam cylinders 20 in. × 24 in. and air cylinders 14½ inches, 9½ inches, and 5 inches in diameter; the compressors have efficient intercoolers placed between the successive cylinders. The air passes from the low pressure cylinder to the lower of the two intercoolers and thence to the intermediate cylinder. From the latter the air is delivered through a vertical pipe to the upper intercooler, whence it passes through an incline pipe to the high pressure cylinder and from this to the pipe line. The various stages show air pressure of 85, 260, and 850 pounds per square inch.

The air is transmitted down a bore hole located about 75 feet south of No. 1 shaft, to No. 1 shaft level, 715 feet below the surface.

There are four charging stations on this level, one in the North Tunnel about 450 feet from the shaft, one in the South Tunnel, another in the south dip of the Holmes seam at the West Tunnel, and a fourth at the south end of the West Tunnel in the Top Split, at distances from the shaft of 850 feet, 1,350 feet, and 2,250 feet, respectively.

The local officials calculate a motor to run in 4,000 feet beyond the charging station with a trip of empty cars, and return with a trip of loaded cars, but in cases of extreme necessity they have done even better. Charging stations are of both Baldwin and Porter manufacture.

In the two shafts there are seven locomotives, one 12-ton, three 11-ton, one 10-ton, and two 8-ton. Both Porter and Baldwin engines are in use. One Porter cross-compound 7 in. × 14 in. and 14 in. × 14 in. (two stage) is being tried out, and it appears to be much stronger and consumes less air, although no tests have been as yet conducted to determine its efficiency. The other Porter locomotives are 8 in. × 12 in. size, as are two of the Baldwin make; two other Baldwins are 5 in. × 12 in.

Two locomotives are on No. 2 shaft level, one down the slope, another upon No. 7 plane, and three on No. 1 shaft level. One of the latter three locomotives is engaged about one-half of the time shifting and hauling rock, which is deposited in old breasts from lower levels and which aggregates 50 to 60 cars a day.

The weight of the empty cars is 3,700 pounds and of the loaded about 10,300 pounds. Both cars and wheels are made at the Reading shops at Pottsville. The gauge of the track is 48 inches.

A modern reinforced-concrete engine house has been constructed in the Middle Split of the Mammoth seam at the North Tunnel. The roof is artistically arched and the roof and sides are kept whitewashed thus presenting a neat and clean appearance. It is 12 feet wide and 65 feet long and accommodates the three locomotives on that level.

The two Norwalk compressors at Maple Hill are assisted by two similar ones at the Ellangowan Colliery about a half a mile to the north. All the compressed air produced at the Ellangowan plant is not utilized in that mine, and a 3-inch line, 3,200 feet long from the compressor house, extends underground to Maple Hill, connecting with the 5-inch line in the North Tunnel.

A decided advantage of the compressed air system is that each section of the piping is equipped with: 3-inch flanged tee, 3-inch male flange, 3-inch male flange tapped for a 2½-inch pipe, 3-inch female flange, 3-inch flanged gate valve, complete with nuts, bolts, and gaskets, for the purpose of converting it into a water-line in case of fire. It will be noticed that the fittings are 3-inch size, for the 5-inch pipe does not extend beyond the tunnel.

There is no method of comparison of the relative efficiency of mule haulage with that of compressed air locomotives at Maple Hill for the reason that the present system has been in vogue for the past twelve years, and the number of locomotives in use has been increased from time to time as necessities required. A comparison based on the mules and drivers displaced by the first locomotives installed would be odious as the conditions have changed materially since then.

An empty car hoist near the foot of No. 1 shaft elevates the cars up a 10-degree grade, 161 feet long, whence they run by gravity to the turnout where they are picked up by the locomotives. This empty car hoist is operated by a 16″ × 24″ compressed air engine made in the Reading shops. A similar hoist is located at No. 2 shaft bottom driven by 10″ × 14″ Snell and Meharg engine. This

haul is 60 feet long on a grade of 21 degrees.

Compressed air haulage has a decided advantage over other methods because it is equally safe in gaseous and non-gaseous mines, its flexibility is supreme, it can enter any workings where track is laid, far beyond the piping limits, it costs little or nothing when not in actual use, its full power, or a fraction of it, is always available assuring almost absolute reliability, there is nearly a total absence of repairs, no loss of radiation and condensation, its capacity for storing power makes it valuable for intermittent work, and its exhaust helps rather than hinders ventilation.

The Prevention of Overwinding

A device to prevent overwinding demands that the control of a hoisting engine be taken out of the hands of the engineer if the cage passes a certain point, say 3 or 4 feet above the landing. Such a device must shut off the steam and apply the brake instantly, so that the cage shall not travel more than from 10 to 15 feet before it is brought to a stop, and held in suspension above the shaft. Such a device, which consists of a few valves, levers, a ram, some pipes, and a weight, is shown in Fig. 1.

There is a revolving hub having projecting arms which travels to the right on a threaded shaft when the cage is ascending and to the left when it is descending. The length of the horizontal movement of the hub corresponds to the exact distance from the bottom to the top landing, and should the cage travel 3 or 4 feet above the top landing, the arms on the revolving hub will strike a lever which opens a valve and sends steam to a ram whose piston puts on the brake and closes the throttle almost instantaneously. The engineer has no volition in the matter, the control of the engine is out of his hands, and before he can recommence hoisting he must reset the device.

There is a regulator on this machine which, should the engineer fail to slow down as the cage reaches a certain point near the top of the shaft, will by the increased speed of rotation raise a weight, shut off the steam, and also apply the brake.

The apparatus occupies little space on the floor and is a positive check on overwinding. The only possible way to prevent its stopping the engine in case of overwinding would be to shut the steam off from it. Its very simplicity recommends it. When hoisting in balance, the two drums being fixed on the same shaft, but one overwinding device is needed because both cages travel specified distances relative to each other.

If, however, one drum is fixed and the other loose, or if drums are loose on the shaft to hoist from different levels, two devices are required, one for each drum. The drum shaft is connected to the overwinding device by a sprocket chain, and the regulator to the overwinding device by another sprocket chain. In case the drums were loose on the shaft the overwinding sprocket would be fastened to the drum.

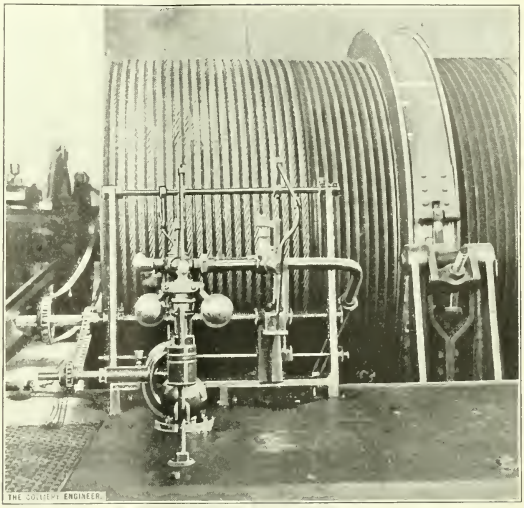


Fig. 1. The Welch Overwinding Device

An Efficient "Sprayer" in Northumbria

In Northumberland and Durham, England, for a period of nearly a decade there has been in operation at some of the mines a device similar in appearance to an ordinary mine car, a description of which is given as follows: It is entirely enclosed and internally is provided with simple pumps and valves driven direct from the axle. Only six moving parts are added. No glands or troublesome gearing are needed. The car is filled with water and directly motion is given, or when attached to the ordinary haulage set, if required, it will begin to spray the adjacent surfaces. The water is drawn from the tank, forced through an air vessel, and from thence to one or more nozzles of special design. By these jets the liquid is broken up and forcibly ejected as an inverted cone of finely divided spray. These cones, impinging on each other, cause the liquid to be completely atomized.

The Storage Battery Locomotive

Its Application to Gathering Coal in Mines—Method of Calculating Size of Locomotives and Battery Needed

By Arvid R. Anderson, M. S.*

AMONG the various uses to which the storage battery is put, there is none which deserves more attention and which promises a more interesting development than its application to locomotives for mine haulage.

It has been only comparatively recently that the development of the storage battery has been such as to make application to mine service practical. Ruggedness, durability, and ease of up-keep are the factors of prime importance in this connection, and when the storage battery was made that first embodied them, then did the possibility of its application to industrial haulage come up for serious consideration.

Fig. 1. Storage-Battery Locomotive

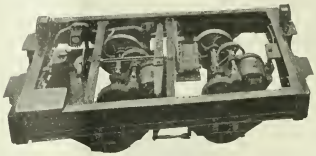


Fig. 2. Locomotive Frame

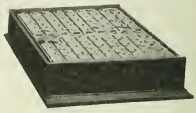


Fig. 3. Storage-Battery Cells

It must not be understood that the storage battery is applicable to all forms of haulage; such is emphatically not the case. Where any great speed is required; where grades are bad; where the haulage is long, or continuous service is required, and where facilities for charging, both in regard to time and equipment, are not convenient, it is not likely that a storage battery will be permissible—because the price and over-all dimensions of a locomotive of such requirements would be prohibitive.

In general, a storage battery locomotive may be profitably employed in places where the grades are not severe; where a speed not exceeding 5 miles per hour is sufficient; where the hauls are not long, say not exceeding ½ mile, and where the service is reasonably intermittent. These conditions, however, are not to be considered hidebound, for charging the battery several times a day may very greatly alter the foregoing; but it is well to bear in mind that the applicability of the storage battery locomotive may be limited by the conditions of service.

An urgent demand for storage battery locomotives is becoming more and more evident in gathering loaded cars in coal mines. At present, electric gathering locomotives used for this service are equipped either with a reel on which is wound an electric cable, or with a reel on which is wound a wire rope.

The locomotive equipped with the former device is so constructed that the end of the cable may be attached to the trolley wire, and the cable allowed to unreel as the locomotive runs into the room where the coal is being mined, and in which no trolley wire is provided. As the locomotive comes out of the room with the loaded car, the cable is again wound upon the reel by means of a mechanism provided for this purpose.

The locomotive provided with the wire rope is commonly known as the "Crab" locomotive, and its operation consists in pulling the loaded car out of the room with this rope, while the locomotive remains in the entry.

Of these two locomotives, the one with the electric cable reel, has by far the widest application, and has proved itself a very satisfactory and serviceable device for the work for which it is intended. In fact, the production of the cable reel locomotive has so materially decreased the cost of gathering coal that the mine operators have considered it a profitable thing to still further exert themselves along this line in the hope that a still more efficient and satisfactory device may be brought out for doing this work.

The introduction of gathering in mines by the storage battery locomotive is due to those operators who believed it to be the solution of the problem for the efficient and economic gathering of coal.

The battery equipment necessary will have to be determined for each particular case, although it is possible to design an equipment which would cover the average case, but this equipment, while it would be of ample capacity for some cases, would, perhaps, fall short of the requirements of other cases, and for this reason it is well to consider each case individually and determine the size of battery required.

If the log of a day's run is known and the condition of all portions of the haulage given, the kilowatt-hours battery capacity required may be calculated by a long and tedious process. Inasmuch as the variation in the work of the locomotive for different days does not warrant so great refinement in the calculation of the battery it is proposed to present a method whereby the battery equipment may be calculated by the substitution of certain data in a few equations. Only such assumptions and approximations are made as have been justified by experience, and the accuracy of the results obtained will

*Electrical Engineer for the Jeffrey Mfg. Co. Columbus, Ohio.

be consistent with the accuracy of the data furnished.

The first step in the calculation is the determination of the weight of locomotive necessary to develop the maximum drawbar pull required. This maximum drawbar pull depends upon the weight of the train to be hauled, the rolling friction, and the grades encountered For ordinary mine cars, a rolling friction of 30 pounds a ton is generally accepted as representing a fair average. To overcome grades, a drawbar pull of 20 pounds a ton for each per cent. of grade is required. If we have a maximum train of six loaded cars weighing 3 tons each to be hauled up a maximum grade of 4 per cent., then the maximum drawbar pull that the locomotive must develop is $6\times3[30+(4\times20)]=1,980$ pounds.

With chilled tread cast-iron wheels the coefficient of rolling friction between the wheels and the track is .20 and with steel-tired wheels it is .25. If we assume a locomotive having steel-tired wheels, and let W represent the weight of the locomotive in tons, then, $.25\times2,000\times W=1,980+(4\times20\times W)$, whence,

$$W=\frac{1,980}{500-80}=4.71 \text{ tons}$$

In other words, the minimum weight of locomotive that could be used is 5 tons.

It will be noted that in this calculation no account has been taken of the accelerating force required at the drawbar. If the characteristics of the motor and battery are known, and the amount of resistance in circuit on the starting point of the controller is known, then the drawbar pull required for acceleration may be accurately determined. Practice has shown that a locomotive calculated simply as above will prove satisfactory in point of drawbar pull for acceleration, and so the complication of this additional calculation is avoided. An explanation of this may be made briefly as follows: A locomotive for mine work will be calculated generally for a maximum grade of not less than 2 or 3 per cent., and very frequently more. With a maximum grade of 3 per cent. the maximum drawbar pull required as calculated above, is $30+(3\times20)=90$ pounds per ton.

Now the drawbar pull required for acceleration will ordinarily be from 10 to 15 pounds per ton. At 10 pounds per ton it is seen that the drawbar pull required for acceleration is only 11 per cent. of the maximum drawbar pull, and with the incidental extra allowance on the weight of the locomotive and with sanding the track, it has been found that a locomotive as calculated above will negotiate the maximum grades satisfactorily, starting from rest. Starting from rest on any other than the maximum grade, the drawbar pull for acceleration increases until on level track there is from four to six times the necessary drawbar pull available for acceleration.

The size of battery with which it will be necessary to equip this locomotive is arrived at from two separate and distinct considerations, and the size of battery chosen will be the maximum given by either one of these considerations.

First of all, the speed at which the maximum drawbar pull must be developed furnishes a basis on which to estimate the size of the battery. If 60 per cent. be assumed as the average efficiency of the locomotive, then in the following equation:

$$\frac{(\text{D.B.P.})\ (\text{M.P.H.})\times5,280\times746}{60\times33,000\times.60}=EI$$

In this equation D. B. P. represents the drawbar pull, M. P. H. represents miles per hour, E represents the voltage across the battery, and I the current discharge from the battery. By transposing E this equation gives the current discharged from the battery, thus:

$$I=3.32\ \frac{(\text{D. B. P.})(\text{M. P. H.})}{E} \qquad (1)$$

Fig. 4. Storage Battery Locomotive, Glendower Colliery

If I_n represents the normal discharge rate of the battery, and K the ratio of the actual discharge rate to the normal discharge rate, then if the battery is to consist of Edison cells, the voltage across the terminals of the battery may be represented by the expression $N\ (1.30-.095\ K)$, where N is the number of cells. Substituting this expression for E in the above equation, and substituting for I the expression $K\ I_n$, equation (1) becomes

$$K\ I_n=3.32\ \frac{(\text{D. B. P.})(\text{M. P. H.})}{N\ (1.30-.095K)}$$

from which is deduced

$$I_n=3.32\ \frac{(\text{D. B. P.})(\text{M. P. H.})}{K\,N\,(1.30-.095K)} \qquad (2)$$

In this equation it becomes necessary to decide upon values for N and K before it is possible to determine the value of I_n. The value of N will depend chiefly upon the voltage available for charging, or upon the motor equipment of the locomotive, and will ordinarily be determined on the basis of voltage per cell at normal rates of charge and discharge. For

example, if the voltage available for charging is 220 volts, then, since the maximum voltage per cell required to charge at the normal rate is 1.85 volts, the number of cells that may be used is

$$N = \frac{220}{1.85} = 119$$

The choosing of the proper value of K will depend upon the length of time that the locomotive is developing the maximum drawbar pull or some other high value of drawbar pull which is sustained for any considerable length of time. The choice of the proper value for K will depend largely upon the judgment and experience of the individual.

In general, it will be safe to give the factor K a value of three, unless the maximum drawbar pull is sustained for a considerable time. If the maximum drawbar pull is continuous, the value of K will be 1; if it is sustained for, say, 25 per cent. of the time, the value of K may be 2; and if the maximum drawbar pull is exerted merely for an instant, it might be possible to give the factor K a value of 4, or even 5; so it would seem that the size of battery arrived at on this basis will, after all, be quite a flexible quantity, depending to a considerable extent upon the person who is to determine the size of battery. In general, it will be safe practice to choose a value of K equal to 3.

The next step, which is the calculation of the size of battery on the kilowatt-hour basis, is by far the more important, and is the way in which the size of battery will in most cases be determined, unless in order to develop the necessary drawbar pull from the battery determined in this way, a value of the factor K is necessary which is evidently too great.

The power taken from the battery may be divided into two parts; viz.: that required to haul the train of cars, and that required to haul the locomotive. The reason for this division of the load will be evident later, when it is seen that by this means it is possible to reduce the entire route to an equivalent length for the locomotive, and an equivalent length for the train.

For convenience, the route of the locomotive in its work of gathering coal will be divided into three parts. The first part is the distance from the side track on the main entry to the first room worked on the side entry. In the following discussion, this distance will be denoted by L. The second part will be considered as the

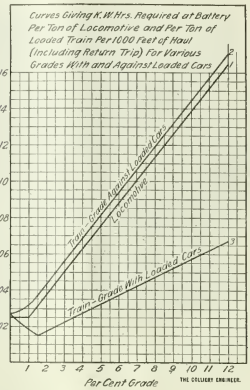

Curves Giving K.W.Hrs. Required at Battery Per Ton of Locomotive and Per Ton of Loaded Train Per 1000 Feet of Haul (Including Return Trip) For Various Grades With and Against Loaded Cars
K.W.Hrs. at Battery
.16
.14
.12
.10
.08
.06
.04
.02
Train Against Loaded Cars
Locomotive
Train Grade With Leaving Cars
1 2 3 4 5 6 7 8 9 10 11 12
Per Cent Grade
THE COLLIERY ENGINEER

Fig. 5

distance on the side entry from the first room worked to the last room worked, and this distance will be denoted by D. The third part of the route consists of the rooms in which the coal is mined, and the maximum depth of these rooms, that is, the distance from the entry to the face of the coal, will be denoted by d.

As a basis to work from, the power required at the battery to haul the locomotive alone forth and back on 1,000 feet of track for various grades, and also the power required at the battery per ton of loaded train to haul forth a train loaded, and back empty on 1,000 feet of track for various grades, will be determined. For the train, two conditions will have to be considered; first, when the grade is against the load, and second, where the grade is with the load. Since the weight of the locomotive is constant, it obviously makes no difference in the power consumption of the locomotive which way the grade lies.

Considering the locomotive, a tractive effort of 20 pounds per ton is required on level track and an additional 20 pounds per ton for each per cent. of grade. On level track then, the energy required at the battery per ton of locomotive weight to make the 1,000 feet haul forth and back is

$$e = \frac{2 \times 1{,}000 \times 20}{.60} = 66{,}600 \text{ ft.-lb.}$$

which, reduced to kilowatt-hours, becomes $e = .0251$ kilowatt-hours. With a track grade of 1 per cent. the power required to haul the locomotive forth will be

$$e = \frac{1{,}000 \times 40}{.60} = 66{,}600 \text{ foot-pounds}$$
$$= .0251 \text{ kilowatt-hour}$$

The locomotive will coast back on all grades above 1 per cent., and consequently the power consumption will be only that required to haul the locomotive up the grade, and may be calculated as above for each grade. These results are plotted in the form of Curve 1, Fig. 5, and show the kilowatt-hours required at the battery per ton of locomotive weight for various per cents. of grade.

Considering now the train, first, as being hauled on a level track. The power consumption per ton of loaded train hauled 1,000 feet, assuming 30 pounds drawbar pull per ton, will be

$$e = \frac{1{,}000 \times 30}{.60} \text{ foot-pounds}$$
$$= .0188 \text{ kilowatt-hour*}$$

The power required to return the train empty, will be in the proportion of the weight of the empty car to the weight of the loaded car. This ratio of weight of empty car to weight of loaded car has an average value of .4 and is approximately constant for all weights of cars. The power required to return the empty train then, per ton of loaded train, will be

$$e = \frac{.4 \times 1{,}000 \times 30}{.60} \text{ foot-pounds}$$
$$= .0075 \text{ kilowatt-hour}$$

and the total energy per ton of loaded train on level track will

*One foot-pound equals .000000377 kilowatt hour.

be $e = .0188 + .0075 = .0263$ kilowatt-hour. Assuming a track grade of 1 per cent. against the load, the energy required per ton to haul the loaded train 1,000 feet will be

$$e = \frac{1.000 \times (30+20)}{.60} \text{ foot-pounds}$$
$$= .0301 \text{ kilowatt-hour}$$

The energy required per ton of loaded train to return the empty cars will be

$$e = \frac{.4 \times 1,000 \times (30-20)}{.60} = .0025 \text{kw.hr.}$$

and the total energy per ton of loaded train operating on a 1-per-cent. grade against the load will be $e = .0301 + .0025 = .0326$ kilowatt-hour.

On grades greater than $1\frac{1}{2}$ per cent. the train will coast back, and the energy required will be only that necessary to haul the loaded train up the grade.

The above calculations have been made for various grades, and the results plotted in the form shown by Curve 2.

When the grade is with the loaded train, the power required is calculated in a similar manner, and the results of such a set of calculations are given by Curve 3. For a locomotive of a given weight hauling a train of given weight loaded and operated over a given track grade, either with or against the load, for a given distance, it is evident how the the attached curves may be used to obtain the power consumption at the battery per trip.

In order to apply these curves to a locomotive gathering coal in a mine, it will be assumed that the train hauled to and from the side track in the main entry consists of n cars. The only part of the route, however, which the complete train of n cars is hauled is from the side track to the first room worked. From there on, the train is not hauled as a unit, but cars are dropped off, pushed into the rooms, hauled out and picked up in the process of gathering. The problem which will be undertaken is to reduce these operations so far as power consumption is concerned to an equivalent length of haul for the locomotive and for the complete train of n cars. If this can be done, it is evident that the curves may be applied and the calculations made.

The data on the first part of the route as outlined in a preceding paragraph are of course already in the desired form. For the first part the length of haul for the locomotive is L, and the length of haul for the complete train of n cars is L.

Considering the second part of this route, namely, on the side entry between the first and last rooms worked, it is evident that the locomotive traverses each portion of the track only once in each direction for each trip, and consequently the length of haul for the locomotive on this portion of the route is the distance between first and last rooms worked, or D. With a train consisting of n cars the average distance between points on the entry where cars are uncoupled from the train and pushed into the rooms is $\frac{D}{(n-1)}$. If w represents the weight of one car in tons, then, assuming this one car is detached from the train at the first room worked, one of the remaining cars in the train is hauled a distance $\frac{D}{(n-1)}$ to the next room worked, and the energy required to haul this car the distance $\frac{D}{(n-1)}$ is $e_1 = k\,w\,\frac{D}{(n-1)}$ where k is a constant depending upon the grade. The next car in the train is hauled a distance $\frac{2\,D}{(n-1)}$ before it is detached, and the energy required to haul this car is

$$e_2 = k\,w\,\frac{2\,D}{(n-1)}$$

Thus the energy required for each car is directly proportional to the distance it is hauled until the energy required to haul the last car detached from the locomotive is

$$e_{(n-1)} = k\,w\,\frac{(n-1)D}{(n-1)}$$

The summation of these energies is the total energy required to haul the train from the first to the last room worked, detaching one car at a time, or

$$\Sigma e = e_1 + e_2 \ldots + e_{(n-1)} =$$
$$\frac{k\,w\,D}{(n-1)}\,[1+2 \ldots +(n-1)] \quad (3)$$

Representing by l_1, the distance which the above total energy would haul the complete train of cars

$$\Sigma e = k\,n\,w\,l_1 \quad (4)$$

Equating (3) and (4) and reducing, the equivalent length of haul for the train becomes

$$l_1 = \frac{D}{n\,(n-1)}\,[1+2 \ldots +(n-1)]$$

Since each car returns loaded over exactly the same track it traverses empty, it is evident that the curves may be at once applied to this part of the route in the same manner as they are to the first part. It may be remarked that in deducing the above expression for l_1, the track grades on all parts of the entry were assumed equal, and consequently the constant k disappears. Actually, of course, this is not the case, but ordinarily the data submitted will not give in detail the variations in track grade between rooms. The information on this point will generally be given in the form of average track grade on entry between first and last rooms, and this average value will be the one used when applying the curves to the above equivalent length of haul l_1. Irregularities in the performance of the locomotive which cannot be determined discredit any further refinement than this.

Considering the third part of the route; viz., that in the rooms. If the first room worked were of the maximum length d and the length of the rooms gradually decreased until the last room was just being started, then the average length of the rooms would be $\frac{d}{2}$. Such a uniform variation in the length of rooms, however, will not actually exist. The first room will not have quite the length d, but the other rooms will usually be a little longer than they would be if the direct proportion were followed. Consequently the average length of rooms will be a little more than $\frac{d}{2}$, and it has been found that 1.25 is a fair value for the factor by which to multiply $\frac{d}{2}$ to give the actual average length of room. The actual average

length of room, then, is $1.25\times\frac{d}{2}$ or .625 d. To cover such switching operations as are necessary in the rooms, this average length is increased 50 per cent., and what may be called the equivalent average depth then becomes $1.50\times.625\,d=.94\,d$, or, in round numbers, the equivalent average length of room may be called d. One car is handled in each room and the work done per trip in handling cars in rooms is equivalent to hauling one car a distance $n\,d$, or a train of n cars a distance d. The equivalent length of haul for the train of n cars, then, on this part of the route, is d. The locomotive, of course, has to enter every room where a car is loaded, and, obviously, the equivalent length of haul for the locomotive on this part of the route is $n\,d$. This part of the route is thus reduced to equivalent lengths the same as the other parts, and to apply the curves, the average grade in the rooms is used which is warranted and justified in the same way as for the other parts of the route.

To make the foregoing readily applicable, the equivalent lengths of haul may be summarized as follows:

Part of Route	Equivalent Length of Haul	
	Locomotive	Train
Side track to first room	L	L
On side entry in front of rooms	D	$\frac{D}{n(n-1)}[1+2..+(n-D)]$
In rooms	$n\,d$	d

As an example, let it be required to specify a storage battery locomotive to operate under the following conditions, locomotive to haul 70 cars per day in trains of 5 cars each: Each car weighs, loaded, $1\frac{1}{2}$ tons; distance from side track to first room worked, 1,000 feet; maximum grade, 6 per cent. against load; average grade, 3 per cent against load; distance from first to last rooms worked, 600 feet; maximum grade, 5 per cent. with the load; average grade, 2 per cent. with load; maximum depth of rooms, 250 feet; average grade in rooms, 3 per cent. against load; speed, $3\frac{1}{2}$ to 4 miles per hour; weight of loaded train of 5 cars $=7\frac{1}{2}$ tons.

Drawbar pull required to haul loaded train up 6-per-cent. grade, $7\frac{1}{2}[30+(6\times20)]=1{,}125$ pounds.

Tractive effort required $=1{,}125+(6\times20\times W)$, and with steel-tired wheels, $1{,}125+(6\times20\times W)=.25\times2{,}000\times W$ or, weight of locomotive is $W=2.98$, say, 3 tons.

It is probable, however, that with the weight of battery which will be required it will not be possible to build a locomotive of sufficiently rigid mechanical construction as light as 3 tons, and, in consideration of this, the weight of the locomotive will be taken as 4 tons. It is required that the speed of the locomotive shall be 3.5 miles per hour when developing the maximum drawbar pull. An Edison battery is to be used, and the contemplated motor equipment has 75 volts. Since the average discharge voltage per cell of Edison battery is 1.2 volts, the number of cells required is

$$N=\frac{75}{1.2}=63$$

Assuming a value of $K=3$, and substituting in equation (2)

$$I_n=3.32\,\frac{1{,}125\times3.5}{3\times63\times(1.30-.095\times3)}=68 \text{ amperes}$$

The normal discharge rate of the A-8 battery is 60 amperes, so that the size of battery consists of 63 A-8 cells. The size of battery is determined by the second method, as follows:

Calculations are for one trip only. $L=1{,}000$ feet, average grade 3 per cent. against load. Kilowatt-hours required for locomotive $=4\times\frac{1{,}000}{1{,}000}\times.05=.20$. Kilowatt-hours required for train $=7.5\times\frac{1{,}000}{1{,}000}\times.056=.420$. $D=600$ feet, average grade 2 per cent. with load. $\frac{D}{n\,(n-1)}[1+2\ldots(n-1)]=\frac{600}{5\times4}[1+2+3+4]=300$ feet.

Kilowatt-hours required for locomotive $=4\times\frac{600\times.0375}{1{,}000}=.09$. Kilowatt-hours required for train $=7.5\times\frac{300}{1{,}000}\times.0175=.0394$. $n\,d=5\times250=1{,}250$ feet, average grade 3 per cent. against load. $d=250$ feet. Kilowatt-hours required for locomotive $=4\times\frac{1{,}250}{1{,}000}\times.05=.25$. Kilowatt-hours required for train $=7.5\times\frac{250}{1{,}000}\times.056=.105$. The total kilowatt-hours required per trip is the sum of all these, or total kilowatt-hours per trip $=1.104$. Number of trips per day $=14$. Total kilowatt-hours per day $=14\times1.104=15.5$ kilowatt-hours.

In order to allow for the decreased kilowatt-hour capacity of the battery when discharging, as it does in this kind of service, at a rate greater than the normal discharge rate, and to provide for reasonable emergencies, such as switching on the entry, pulling cars back on the track, excessive stopping and starting, running with brakes set part of the time, etc., the kilowatt-hours obtained above are multiplied by the factor 1.35 to give the kilowatt-hour capacity at normal discharge rate of the battery required: $1.35\times15.5=20.9$ kilowatt-hours.

The kilowatt-hour capacity of 63 A-8 Edison cells is 22.5 kilowatt-hours and this battery, which is the same as the one arrived at from the first consideration, would be the one specified.

It is evident that this method of calculation may be followed not only for determining the battery equipment of a coal gathering locomotive, but for determining the battery equipment necessary on any other industrial haulage locomotive as well, where the route and operations of the locomotive are described.

The committee of management of the International Engineering Congress, 1915, takes great pleasure in announcing that Col. George W. Goethals, chairman of the Isthmian Canal Commission and Chief Engineer of the Panama Canal, has consented to accept the honorary presidency of the Congress and will preside in person over the general sessions to be held in San Francisco, September 20-25, 1915.

Mining Plant of the Petros Coal Co.

With Special Reference to the Operation of the Gravity Plane and the Use of a Five-Car Rotary Dump

By A. W. Evans*

THE coal property of the Petros Coal Company is situated in Morgan County, Tennessee, on the head waters of Crooked Fork Creek, 6,674 feet northeast from the town of Petros. The property consists of 1,600 acres, and is known as the Fischer tract. The northern boundary is under the center of Fodder Stack Mountain, and the southern boundary is on the southern escarpment of Big Brushy Mountain. There are four workable seams of coal; i.e., Coal Creek, Brushy Mountain, Dean, and the Middle Pioneer.

The operation herein described is on the Brushy Mountain seam, and the coal will average 40 inches in thickness. The cars are brought from the mine, which is a drift operation, by mules to the top of the incline. This incline plane operates by gravity, the rope going around a drum, located about 50 feet back from the head, on the center line of the plane. The drum, which is set 26 feet higher than the head of the incline and at right angles to it, consists of two 6-foot sheaves, rubber filled, with brakes on each sheave. The rope used on the plane is the lang lay, 6-strand 8-wire, 1 inch in diameter.

*Mining Engineer, Chattanooga, Tennessee.

The plane is 717 feet in length, with a maximum grade of 22 degrees; three rails are laid above the parting, and two below, both of 20-pound section. The switch rails at the lower end of the parting are held in place by a unique arrangement, consisting of a buggy spring, one side of which is bolted to the tie, and the other side is attached to the tie-bar of the switch points, by a strip of iron 6 inches long and 1½ inches wide, bolted to the center of the tie-bar. The spring is under tension, and exerts its force against the switch points after they are thrown over the center by the descending trip, thus holding the switch points safely for the trip going up.

At the head of the plane the three rails extend over the knuckle, and merge into a single track, which forms the loaded track; this track is depressed at the knuckle, in order to give a gradient that will start the trips from rest, on their way down the plane. At a point down the plane 37 feet from the knuckle, the empty tracks branch out right and left from the main tracks of the plane, pass over the knuckle on each side of the tracks for the loaded cars, and come together at a point 60 feet from the head of the plane. At a distance of 50 feet back from the head of the plane, the left-hand empty track passes under the loaded track, and joins the other empty track, and thence to a side track, where the cars are taken by mules for distribution. The grades are so arranged that the empty cars run away from the head of the plane by gravity, and the loaded cars run toward it.

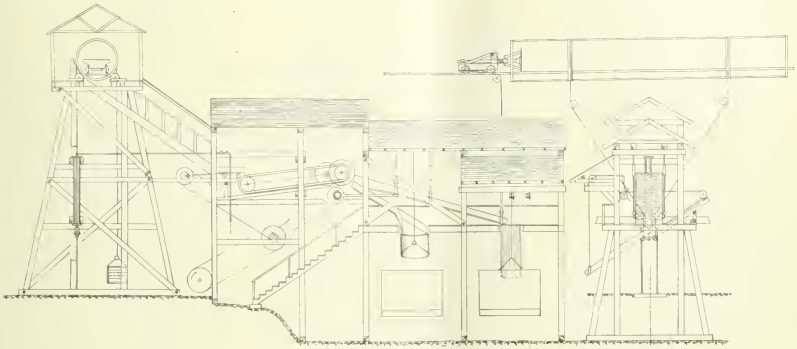


FIG. 1. LONGITUDINAL AND CROSS-SECTION OF DRUM AND TIPPLE

In the erection of the plant, a departure was made from the usual custom of tipping the coal, by installing a 5-car rotary dump; the construction detail is shown in Fig. 2. The dump is constructed of 6 circular webs, made from 40-pound rails bent to a circle of 6 feet diameter; these webs are spaced at 8-foot centers, and held rigidly in place by longitudinal channel bars and the track rails, as shown. The dump is on a 2-per-cent. grade; its full length is 42 feet, in order to accommodate a 5-car trip. Nine feet from each end is placed a 6″ × 2″ channel bar bent to the radial line of the dump, to serve as a drum for the rope that actuates the dump.

Both ends of the ropes on the

same side of the tipple are attached to a cross-bar fixed on the piston rod of a steam ram, or "shot-gun" feed, as it is commonly known. The rope, which is 6-strand, 19-wire, ½-inch wire rope, has three laps around the drum of the tipple, and the other two ends, on the opposite side of the dump, are attached to the weight basket, to counterbalance the dump and the five empty cars. See Fig. 1 for detail.

The cylinder, or steam ram, is placed in a vertical position, and held in that position by timbers, as shown in Fig. 1; the full stroke of the cylinder is 10 feet, but as the travel of the dump is only 8 feet, a 24-inch block of wood with a rubber cushion on the top is placed in the lower end of the cylinder to afford a proper stroke.

To guide the piston two 1½-inch pipes were used, bolted at the top and bottom to timbers, and the cross-arm on the end of the piston rod is fitted with two rollers which engage the pipes. Air or steam is conducted by a 1¼-inch pipe, and admitted to the upper end of the cylinder; as there is no necessity for steam or air under the piston head, since the weights pull the dump back, after tipping, two ordinary globe valves are used; both valves being closed, the valve governing the pressure is opened, and the air is carried direct to the cylinder, and the dump revolves. When the stroke is completed the valve governing the exhaust is opened, and the weights pull the dump back to its original position.

The five cars enter the dump attached to the incline rope, and are brought to rest by the buffer car shown in Fig. 1. This car, which is built of 12″ × 12″ timbers bolted together and mounted on 12-inch wheels, carries a 4-inch shaft, on one end of which is mounted a 40-inch circular plate of 58-inch steel that serves as the buffer This plate is attached to the shaft by a heavy cast-iron shoe, and revolves freely; there are four arms of 4-inch wrought iron bolted to the back of this plate, and to a 4-inch wrought-iron collar around the shaft. This collar rests directly against a coil spring of 1¼-inch steel, which takes the first thrust of the incoming trip. If the momentum is such that the trip is not brought to rest, the cars can move the buffer car, which is held in

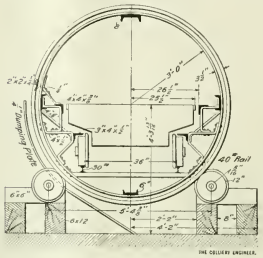


Fig. 2. Cross-Section of Rotary Dump

position by weights attached to a car by ½-inch rope.

When the coal is dumped, it drops into a bin, built on a 39-degree pitch, and is then fed to the picking table by a reciprocating feeder. The feeder is 48 inches wide and 3 feet 8 inches long and has a 7-inch stroke, which is easily regulated. The feeder travels at a rate of 60 revolutions per minute.

The picking table, or apron, is made of heavy steel, with corrugated joints and high overlapping ends, thus forming a strong and substantial table of ample capacity.

The apron sections are carried on two strands of self-oiling, steel bar-link, roller chain. The table and reciprocating feeder were purchased from the Webster Mfg. Co., of Tiffin, Ohio.

After the coal is thoroughly picked, it passes to the shaking screen, where it is assorted into the different grades for commercial purposes. The scheme for the preparation of the coal was worked out by A. H. Wood, the manager of the company. The coal is loaded into railroad cars by means of curved chutes; in loading, the movement of these cars is controlled by a car retarder.

Shipping facilities are furnished by the Harriman and Northeastern Railroad. A spur track leaves the main line at Petros and follows Crooked Fork creek for a distance of 7,200 feet. The maximum grade is 2.4 per cent. in favor of the loaded cars. The first car was loaded for shipment on May 15, 1913.

Mine Tracks

Written for The Colliery Engineer

Cheaply constructed tracks on the main haulage roads of coal mines are costly investments, yet many, under the impression that they are economizing, use light rails and ties for heavy traffic.

A 10-ton engine will travel on a 25-pound rail, but in a short time the track will get out of alinement both horizontally and vertically, and grooves will wear in the locomotive drivers and car wheels. Nothing short of a 40-pound rail should be used for a 10-ton locomotive, and 56-pound rails for 15-ton locomotives. There is a difference of ⅜ of an inch in width between the heads of 25-pound and 40-pound rails which hardly accounts for the longer wear of driving wheels without grooving, therefore it is assumed that the lessened vibrations of the heavier rail has much to do with the wear on the car wheels. This theory is strengthened by the writers who insist on main haulage mine tracks being laid on carefully constructed well-drained road beds, supplied with oak or chestnut ties having not less than 6-inch faces, and whose ends extend at least 9 inches each side of the rail.

These writers declare that as much care should be given to the construction of tracks underground as to railroad tracks on the surface; which means that the roadbed should be drained, ties placed so close they will not have over 2 feet centers, angle fish-plate joints, and four spikes in every tie. All this preparation is to the end that the track may be firm and unyielding when sub-

jected to traffic; however, if the track is too light all this will go for naught, but a good stiff rail alone will not keep the cars on the track.

In building track curves, special care should be taken to have the rails bend to conform with the radius, a matter which can be accomplished most satisfactorily at the shop. The outside rail of the curve should be elevated slightly to help the cars change their direction. While 20 and 25 feet radii are often used for curves, a 32-foot radius is convenient and is advised as the shortest radius to be used.

The most critical point in a track is at the switches, and to keep cars on the track these must be carefully laid.

Ground switch stands operated by levers having counterweights are better in mines than upright switch stands, and on main lines split switches are much better than stub switches. Frogs should be selected with a view to fastening them securely to the ties, and with reference to the lead. The length of run from the switch point to the frog should be as long as possible and the frog angle calculated with exactness. Short cast-iron frogs will work loose or break at inopportune times, therefore rail frogs on main lines are recommended.

One of the railroad trackman's rules is to tamp material firmly under the rail and the ends of the ties, and it is a good rule. Ashes do not make a first-class roadbed in the mines, especially where it is wet, and the same remark applies to any dirt; therefore in swales use stone ballast, and not only ditch the main haulage roads but keep the ditches clean.

The United States Geological Survey's report on coal for 1910 contained excellent maps of the coal fields of the United States with brief descriptions by geologists of the Survey. Copies of the report are still available and can be procured free of charge upon application to the Director of the Survey.

Gasoline Mine Locomotives

*By Carl Scholz**

The utilization of gasoline engines for mine haulage is a subject which has attracted the attention of manufacturers and coal-mine operators ever since gasoline road automobiles have been used. The first notice which the writer had of a gasoline mine locomotive was in 1896, when the Prouty Mfg. Co., of Chicago, advertised a 2-ton gathering gasoline mine locomotive. Upon investigating the features such as safety from fire, noxious odors, and transmissions, very little satisfactory information could be obtained, and so far as known none of these locomotives were ever built, or at least not operated in coal mines.

Within the last 3 years, at least two successful manufacturers have taken up the building of gasoline mine locomotives, and upon investigation the writer became convinced that several of the most serious objections had been successfully overcome, and decided to make a trial installation for the purpose of determining the application of the gasoline locomotive for coal-mine haulage. In May, 1912, a 4-ton motor was installed at the St. Clair mine of the Consolidated Indiana Coal Co., at Hart, Ind., and has been in continuous operation since that time.

Notwithstanding the very favorable reports which had been received from other buyers, more or less difficulty was expected in the operation, and defects and weaknesses were anticipated, such as always develop with new devices, to the handling of which men are unaccustomed; but it is gratifying to be able to say that all of the problems were duly solved and the gasoline haulage motor is considered equal, and in some points superior, to other mechanical haulage devices. It is not intended to convey the idea, however, that these machines will in all cases replace electrical or other machines, but they have undoubtedly a field for which they are particularly adapted and will find extended usage.

In considering the gasoline locomotive, investigations were made to cover the following points:

1. The risk from fire and explosion due to the use of gasoline in the confines of a mine.
2. The possibility of gasoline leakage in filling the tanks and handling of gasoline in the mine.
3. The objection to noxious odors of the exhaust.
4. The reliability and freedom from mechanical defects.
5. The operation of a complicated machine operating under high speeds in mine workings and the availability of satisfactory operators.
6. The operating cost as compared with other types of haulage.

The investigation led to conclusions as follows:

1. The risk from fire and explosion in the gasoline locomotive has been reduced to a minimum, and especially on main haulage roads where there is ample ventilation, the air-current dissipates and carries off any vapor that may form more quickly than would be the case in the open air. The vapors from gasoline, being heavier than air, travel close to the bottom where there is less chance of contact with open lamps. There is more danger from the ignition of gas due to sparks from the trolley wheel of an electric locomotive located near the roof in gassy mines. To prevent the leakage of gasoline on the floor, a large cup has been attached to the carbureter, so that in case of flooding the gasoline is spread over a large surface and quickly evaporates. Assuming that the gasoline locomotive is handled no more carelessly than any road automobile, the risk from fire and explosions would be indeed small.

2. The possibility of leakage of gasoline from the tank is reduced to a minimum by a contrivance which prevents the detachment of the gasoline tank from the locomotive until the connecting pipes are fully closed. The gasoline tanks cannot be opened in the mine and must be taken to the filling tanks on the surface before they can be unlocked. The gasoline tanks are set in the center of the main locomotive frame and are well pro-

*V.-P. and G. M., Consolidated Indiana Coal Co.

ieeted against damage from the outside or falls from the roof, and being made of copper, are not subject to breakage.

3. In view of the serious objection found with the average road automobile from the odor of exhaust, this feature was particularly investigated. Because of the desirability to use gasoline locomotives for gathering purposes in rooms and places where thorough ventilation was not always available, reference had been made to the use of chemicals for preventing the escape of odors from the machine. It was found, however, that with the proper carburation and use of oil in correct quantities, no odor was noticeable from the exhaust after it had passed through the cooling tanks where a slight vapor was formed, which was noticeable in the mine temperature to the eye but carried with it no objectionable odor whatever. In one case where leakage in a cylinder developed, with excessive use of oil, several men were overcome very quickly by the fumes from the engine, but upon correcting the difficulty no further objections were found.

4. Notwithstanding the comparative newness of the gasoline mine locomotive, very few defects have developed which interfered with the operation of the machine. The chief difficulties have been in obtaining flawless castings for the cylinders. Some difficulties have been experienced in obtaining proper ignition from a storage battery, which has been overcome by the adoption of magnetos. Mechanically, gasoline locomotives are equipped with brakes operating in the same manner as on other types of motors, and the wheels are fitted with steel tires.

5. In operation, the gasoline motors are as simple to handle as any other self-contained machine. They have a decided advantage over any motor requiring contact, such as trolley or third rail. They are reversed much quicker and handle the loads with the greatest possible ease. The clutch permits starting at very low speed with the full power of the motor. In this respect the gasoline machine has a decided advantage over steam or air motors. A test conducted between an electric trolley and a gasoline motor indicated that the gasoline machine geared at the same speed will handle about 10 per cent. more cars than the electric motor, by reason of the quick reversals and the starting possibilities. More or less difficulty was anticipated in obtaining motor runners who could operate the gasoline machine safely, but the extensive use of automobiles has settled this problem satisfactorily. Practically every mining camp has a number of automobiles, and it has been found an easy matter to obtain reliable gasoline-engine operators.

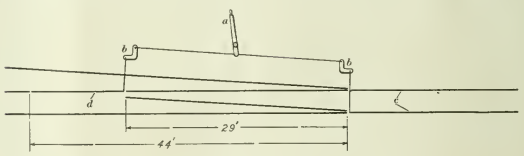
6. It is difficult to arrive at the difference in the cost of operating gasoline motors and electric motors. The gasoline machine is self-contained, whereas in electric haulage expenses connected with the operation of the generating unit, maintenance and installation of conductors and trolley lines must be considered. The average consumption of gasoline and oil for an 8-hour shift on a 6-ton motor is about $2, gasoline costing 17 cents per gallon. While the first cost of the gasoline motor in weight is about 50 per cent. greater than an electrical motor, the absence of the generating unit and conductor makes the cost considerably less. This, of course, depends somewhat upon general conditions and particularly where sufficient electric power is required for other purposes, thereby diminishing the cost of installation and operating.

With a 4-ton machine 406 cars were handled, containing 2 tons each, an average distance of 1,700 feet in 8 hours, with an average trip of 10 cars with one-half of the haul on a grade of 1 per cent. against the load. The most desirable field for gasoline locomotives in addition to hauling on main roadways would seem to be the gathering of coal from the rooms to the partings. The absence of cable as is required for electrical gathering locomotives would make the gasoline locomotive particularly attractive. Every care will, of course, have to be taken to prevent the generation of noxious odors in rooms where the ventilation generally is not as well maintained as on entries. The tendency to increase the size of mine cars, together with the high cost of mules and drivers' wages, calls for a dependable machine, and from present appearances the gasoline locomotive would seem the best adapted for this purpose.

The writer's experience has been so satisfactory that a total of five gasoline motors have been installed within the last couple of months, and others will likely be purchased as conditions require it.

Frogless Switch

Mr. J. Q. McNatt, Division Engineer of the Colorado Fuel and Iron Co., furnishes the following sketch of a frogless switch that is used by the company on a rapid-transit incline at Crested Butte. The switch, which was invented by Messrs. Martin Kuretich and William Johnson, of Crested Butte, has a vertical lever handle *a*, instead of the horizontal handle, as shown in the sketch, which by means of bell-cranks *b* throws the leading rails *c* and the movable rail *d* so as to make connections with either the main line or siding. Its use has saved C. F. & I. Co. much trouble in the way of preventing expensive wrecks.



Frogless Switch

Slope Haulage at Sayreton, Alabama

Methods of Construction and Operation by Which a Record Production Has Been Obtained on a Slope 5,510 Feet Long

By F. G. Morris*

Sayreton slope, on the Mary Lee or "Big Seam," located 4 miles north of the center of Birmingham, Ala., is operated by the Republic Iron and Steel Co., under the directions of C. T. Fairbairn, general manager, F. G. Morris, general superintendent, J. G. Meagher, superintendent, and Frank Ferguson, mine foreman.

The product from Sayreton mine is washed and crushed at the plant, and is coked at the company's ovens at Thomas, Ala. The grade of the slope track, from the knuckle on the tipple to a point 800 feet inside the slope, a total distance of 980 feet, averages 26 per cent.; for the next inside 1,600 feet the average grade is 11 per cent.; from this point to the bottom landing (on the edge of the basin of the coal seam), a distance of 2,600 feet, the grade averages 6.2 per cent., the total distance from tipple knuckle to bottom landing being 5,180 feet. Including the tipple landing room (330 feet) the total one-way haul from the bottom landing is 5,510 feet, and the total rise, that is, difference in elevation between points given, from this bottom landing to the top of tipple is 603 feet. On the incline, cross-headings are turned off right and left every 300 to 400 feet, beginning 1,000 feet from the outcrop, there having been a 1,000-foot outcrop barrier pillar left to hold back surface water and prevent it entering the mine. Below this barrier 14 left and 14 right headings have been turned, driven water level to the boundary lines on their respective sides. As most of the upper headings on the incline have been driven to boundary lines, and work in them suspended, the production is now coming largely from those lower few headings on the incline which have not reached the property line, and from the new development work in the basin. The present output from this slope averages 1,557 tons daily, of which practically one-half, or 800 tons, is assembled and hauled from the basin entries, a total slope distance of 5,510 feet; the other half of the product is gathered from two left headings and four right headings, the average

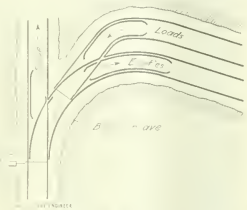


FIG. 1

one-way slope haul from these headings, in proportion to coal from each heading, being about 4,700 feet.

The turnouts to cross-headings are single openings, with empty and loaded tracks. The switch to the two tracks is set just inside the slope switch, there being only one switch on the slope for each heading. The slope is single track, laid with 60-pound rail, from tipple to first working heading, something like 4,000 feet inside the mine. Below this point the slope rail and all turnouts are of 40-pound rail. The entire slope track is laid on 6″×9″ ties, surfaced, alined, and kept well cleaned and sprinkled, and is inspected daily. The joint fastenings or fish-plates on this rail are extra long, fastened with six bolts, thereby insuring a good tight and smooth joint.

Double turnouts from the slope are used only where cross-entries are from necessity turned abruptly off the slope. In such cases empties must be lowered slowly, and loaded cars pulled off the cross-entry slowly in order to avoid wrecks.

The double turnout gives very little trouble at this mine, for the reason that a signal man on the slope signals the engineer when empties are to be run into and loaded cars pulled out of an entry of this description.

Fig. 1 shows a single slope turnout and the way track switches are laid out for the parting. The empty turnout is given a long radius and is the upper track, the loaded cars being assembled on the lower track. The switch points to the loaded track are close to the main-line frog. The empties entering this turnout at a high rate of speed of 10 to 12 miles an hour, are kept from derailing by a double system of guard rails which, on inside the loaded track switch points, and extend the full length of the side track.

The success achieved in preventing derailments is due to keeping the good track, to the signaling system adopted, to the empty trains being heavy; and this, with the retarding effect caused by the heavy rope drag, keeps the couplings stretched at full length, which two factors are largely instrumental in keeping the cars on the rail.

By the signal system the hoisting engineer knows when to slow down before an entry is reached and he allows the empty cars to enter this side track at a speed which he knows will not derail the cars, and which speed must be faster or slower according to the nature or degree of curvature of turnouts, which are well known to the engineer. Fig. 2 shows the method of guarding frogs and switches on short turnouts inside the mine, although it shows a switch from the slope to the timber yard. It also shows the knuckle at the top of the tipple and the mine mouth.

The hoisting engine is an old type 30″×60″ first-motion Vulcan hoist, the drum of which is 9 feet in diameter by 10 feet long, keyed to the shaft, with no clutch or friction to throw out engines when lowering trip. Since about one-half of the coal comes from the 4,700-foot level, and the other half from the 5,500-foot level, and because of the fact that the

*General Superintendent Republic Iron and Steel Co.'s coal mines, Sayreton, Ala.

tipple landing room is limited, the trips are hoisted and lowered at rapid speed. The landing room is limited to an 11-car trip, the hauling period to 10 hours, and the daily tonnage required or needed by the company is "all obtainable." In producing an average daily tonnage of 1,557 tons for 298 days worked in 1912, the operating hours and hoisting cycle were as follows (Average cycle hoisting from 4,700- and 5,500-foot levels):

Number hours per day, 10. Period hoisting trip (from average distance of 5,000 feet), 3 minutes, 5 seconds. Period allowed for trip on tipple, 1 minute; period lowering trip, 2 minutes, 45 seconds; period allowed rope to stop to uncouple and couple rope, 40 seconds; total round-trip time, 7 minutes, 30 seconds. Number of trips hoisted per day for 1912 was from 75 to 84.

The weight of the trip is as follows: Weight empty car, 2,500 pounds; weight coal per car, 3,800 pounds; total weight loaded cars, 6,300 pounds; number cars per trip, 11; weight of coal hoisted, 20.9 tons.

Average hoisting speed, including stopping and starting, 29.7 feet per second; average lowering speed, 33.3 feet per second, or 2,000 feet per minute. The out trip on certain parts of the slope is speeded up to 30 to 40 miles an hour, and during 1912 there was not a single derailment on the 60-pound rail while hoisting, which speaks well for the condition of the track, car equipment, and the carefulness of the hoisting engineer. As to the car equipment, the cars are made heavy, substantially braced, and are equipped with 18-inch bronzed-bushed wheels of the company's special design.

Table 1, the monthly and annual operating sheets, shows the days operated, tonnage per month, and average tonnage per day for each month and for the year. The total tonnage from this mine, viz., 464,066, is the record production of any mine in Alabama and possibly will exceed any mine in the South on a single-track slope.

It is believed that Sayreton set a record in more ways than one in 1912, principally in the regularity of the average daily, monthly, and annual tonnage produced, which I do not believe has been paralleled for a similar long single-track slope. This was accomplished by keeping the

Fig. 2. Switch on Slope

equipment in the highest state of efficiency, thereby reducing delays to a minimum and by having an efficient and loyal organization (from trapper to superintendent), all of which the officials of this company claim for Sayreton. The record daily production from this slope was 1,803 tons.

Table 1. Production For Calendar Year, 1912

Month	Actual Days Operated	Total Tons	Tons Per Day Average
January	26.7	40,980	1,533
February	24.	32,826	1,563
March	25.7	40,107	1,532
April	25.7	40,565	1,578
May	25.7	39,558	1,540
June	24.	37,011	1,542
July	25.7	40,165	1,562
August	24.7	38,139	1,544
September	23.4	37,354	1,596
October	26.	40,783	1,568
November	25.	39,502	1,580
December	24.4	37,076	1,520
Totals	298.0	464,066	1,557

While the mathematical horses are puzzling the solons in Europe by doing square root, division, etc., a stiffened-up mine mule in Dunmore, Pa., takes steam baths by standing in the exhaust of the engine.

Reminiscences of the Schuylkill Region

Mr. Frank Z. Schellenberg, C. E., of Pittsburg, Pa., who for many years has been prominently identified with large bituminous coal interests in Pennsylvania, in a personal letter to the writer, gives some interesting reminiscences of early days in the Schuylkill anthracite region. In his letter, Mr. Schellenberg says:

"The brief extract from the report of the superintendent of the Girard Estate, published in the September number of The Colliery Engineer, recalled to my mind my early engineering experience in Schuylkill County, Pa. In 1860-63 I was on the engineering force building the Mahanoy and Broad Mt. Railroad, now a part of the Reading system. The first ground was broken at Ashland, on December 20, 1860, a day made memorable as that of the secession of the state of South Carolina. From the other terminus of the road, south of the Broad Mountain, we went up Mill Creek and Muddy Run on a grade of 175 feet per mile, and then crossed the top of the mountain on the old level grading made many years before by Stephen Girard, which had an elevation of 1,472 feet above tide. The Mahanoy Plane with a drop of 312 feet into the Mahanoy Valley, has for 500 feet of its horizontal distance a grade of 22 feet in 100 feet and then gradually flattens to a grade of 1 foot in 100 feet at the foot—its beautiful profile concaving with the side of the mountain was a practical layout.

"Some years ago in conversation with a gentleman who, on noticing the rope lying on the rollers for the whole length of a plane, said that it was purposely a 'parabolic curve' and the theoretically best layout, and who instanced a large plane in the eastern part of the state as concrete evidence of its advantage, I said that I knew the place he had in mind, as I was one of the engineers who, while staking out the cross-sections for it, in extremely cold weather, had our luncheons, which we carried in our pockets, frozen.

"We also surveyed a route for the Shenandoah branch from Girardville to Kehley Run before the town of Shenandoah had a single house, not excepting the old tavern which was the first building on the site of that town now of over 25,000 population. Where the town now stands we saw bear tracks in the snow on Thanksgiving Day, 1862.

"During the same year, I went to my home in Minersville, in September, and in compliance with the call of the Governor joined a company that, on arrival at Harrisburg, became Company D of the 19th Regiment of emergency troops to protect the southern border of the state."

Field Test of the Electric Locomotive

By Leonord V. Newton

The problem of electric locomotive testing in the mine is one, the importance of which, I believe, is not fully realized by the mine manager of today. A field test which can be run in a few hours, would show the efficiency of the locomotive and also would show any loss of current due to poor rail bonding or poor wire connections.

To calculate the actual horsepower of the locomotive, it is only necessary to determine the drawbar pull, which, I might say, is that part of the tractive force available for pulling the load, and the speed of the locomotive. The formula for calculating the horsepower then is

$$\text{H. P.} = \frac{P \times D}{33{,}000}$$

H. P. = horsepower;
P = drawbar pull;
D = feet per minute.

The speed being nearly always expressed in miles per hour, it might be well to substitute the above formula and it becomes

$$\text{H. P.} = \frac{P \times S \times 88}{33{,}000} = \frac{P S}{375}$$

P = drawbar pull;
S = miles per hour.

The number 88 is obtained as follows: 1 mile per hour = 5,280 feet per hour, or 88 feet per minute.

To actually determine the drawbar pull, a dynamometer is used. It is fastened between the locomotive and the trips as shown at *a*, Fig. 1. The locomotive is run over a course which should be practically level, and of a length of from 600 to 1,000 feet. The time, in minutes, to traverse this space is taken, and dynamometer readings are made every

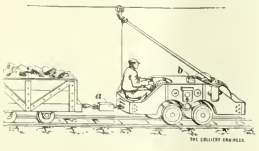


Fig. 1

one-half minute. These readings are taken by a man who sits beside the motorman and, by leaning over, the dynamometer may easily be read. The importance of correct speed, and steady pull cannot be overemphasized, but by taking readings close together and averaging these, very accurate results can be obtained.

The power required to move the locomotive itself cannot be neglected, as it is useful work, and therefore must not be charged to loss. If two locomotives are used in the mine, and they are identical, the drawbar pull necessary to move the locomotive through the given distance could be found. However, by obtaining the weight of the trips hauled in the first test, and calculating the drawbar pull per ton of weight, the pull required to move the locomotive may be obtained by multiplying its weight in tons by the drawbar pull per ton.

Then the formula for the actual H. P. becomes

$$\text{H. P.} = \frac{(P + P')\ (S)}{375}$$

P = drawbar pull to move the trip;
P' = drawbar pull to move the locomotive;
S = miles per hour.

The electrical horsepower may be determined by simply taking successive readings with a watt meter attached to the locomotive as the course is traversed. The watt meter is attached to the trolley pole as at *b* and may be read by a man sitting at the front of the locomotive, readings being taken every half minute.

$$\text{Theoretical H. P.} = \frac{\text{volts} \times \text{amperes}}{746} = \frac{\text{watts}}{746}$$

The efficiency of any machine is equal to the output of the machine divided by the input.

Therefore, in the case of one locomotive the efficiency

$$= \frac{\text{actual H. P.}}{\text{theoretical H. P.}} = \frac{(P+P')(S)}{\dfrac{\text{watts}}{746}} = \frac{375}{\dfrac{\text{watts}}{746}} = \frac{(P+P')(S)(746)(100)}{(375)\ (\text{watts})}$$

The efficiency of the motor of the locomotive runs very high, from 90 to 95 per cent. The efficiency of the locomotive after being in service for some time runs from 60 to 85 per cent.

If the efficiency is low, several things should be investigated. First, the motor—see that the brushes are in good condition, see that oil and gum is not on the commutator; see that the armature is not out of alinement, and that the bearings are in good shape. The next point for investigation should be the wiring, and controller—see that the wiring is intact and that the points on the controller make good contact. The wheels should not be flat, nor should new wheels be used in front and poor ones in the rear of a locomotive. Slipping should be investigated and sand used, and care exercised in starting. Probably nine-tenths of all locomotive trouble is due to neglect. Locomotives are delicate electrical machines and should be kept clean and housed in a room at night, where they can be thoroughly cleaned and oiled by a competent man.

The question of line loss is one which may be discussed very briefly. To determine the maximum loss, take the volt-meter reading at the generator. Then take the volt-meter reading at the farther-

most point in the mine. The difference between the two readings represents the loss. Part of this loss is justifiable; namely, that due to resistance of the trolley. However, this loss should be computed and the rest of the loss should be rectified by repairing the trolley line and looking over all the rail bonds.

In conclusion I would say that a test such as I have outlined would take probably one-half of a day, but the time and money spent in so doing would not be ill spent, as the saving made in correcting these leakages is of quite a large magnitude, especially when leakages are allowed to run year in and year out.

Cost of Mining as Related to Output

Figures Showing Variation of Cost With Varying Output—Suggestions for New Basis for Car Allotment

R. C. Jones*

IT MAY seem somewhat surprising, but it is nevertheless generally true, that the first half of the output of a coal mine costs double what the second half does. For example, upon Fig. 1 cost curves have been plotted which indicate that the first 15,000 tons produced per month cost double that of the next 15,000 tons.

the cost of coal as averaged from mines similarly situated and operating under similar conditions.

The total mining cost is given by Curve I and the total cost, including central office and interest, is shown by Curve II, which represents costs given by Curve I plus a fixed monthly total central office and interest charge. This fixed overhead charge is taken

of production upon total costs. In like manner a similar variation in each item of cost, also of credits, as influenced by the output can be indicated by similar curves.

Thus these curves as plotted for any mine may be called the normal production-cost curves for that mine and indicate particularly the production below which the mine cannot economically operate. Such curves will also indicate whether an increased expenditure of capital to increase output would be advisable.

All cost figures given are for fee mines and are exclusive of royalty charges.

"Tail-End" Coal Is Cheap Coal. The most striking fact, however, brought out by this method of showing costs appears from the following calculations: For example, on Curve II the normal total cost of producing coal at the rate of 30,000 tons per month is 87½ cents per ton, or $26,250. Likewise, the cost of production of 30 per cent. less, or 21,000 tons, will

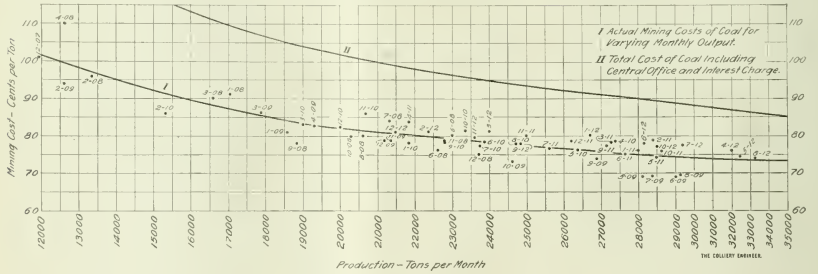

I Actual Mining Costs of Coal for Varying Monthly Output.
II Total Cost of Coal Including Central Office and Interest Charge.
Mining Cost - Cents per Ton
Production - Tons per Month
THE COLLIERY ENGINEER.

FIG. 1

Production Cost Curves.—Upon this chart, Fig. 1, are shown the mine cost and total cost of producing coal by months at a group of mines in West Virginia, based upon figures representing actual data covering a period of 5 years. Such charts have also been plotted for several individual mines in West Virginia and Pennsylvania, but to obviate as far as possible any accidental fluctuations due to other causes than variation in output, the figures used in these charts represent

to avoid the fluctuating charges which actually prevailed in practice due to causes other than varying production. In this way for Curve II the actual central office and interest charge for a year for this group of mines was taken, and this divided by the varying monthly tonnage produced in order to give the overhead charges per ton of coal to be added to the mining cost to obtain total cost, Curve II. These curves, therefore, represent actual conditions and give a graphic picture of the influence

be $1 per ton, or $21,000. Therefore it necessarily follows that the cost of producing the last 9,000 tons was actually ($26,250 − $21,000) = $5,250, or only 58.3 cents per ton.

Similarly, if we assume as before that the average normal shipping capacity of these mines is 30,000 tons per month at a total cost of 87½ cents per ton, that is, $26,250, any factor which reduces the output by 50 per cent., that is to 15,000 tons, brings the cost per ton up to $1.18, or $17,700, thus depriving the operator

*Vice-President Solvay Collieries Co.

of 15,000 tons of coal at $8,550, or 54 cents per ton.

In other words, the first half of the coal produced costs $1.18 and the second half less than half, or only 54 cents per ton.

Loss Due to Decreased Output.—The operator's loss due to decreased output is therefore a double one, first from the high cost of coal actually produced, and second from the loss of cheap coal which he was unable to produce.

After once establishing at each mine or group of mines such a normal production-cost curve, then the loss or gain due to variations in production becomes at once apparent and the amount in dollars and cents can be easily calculated.

For example, assuming a net selling price for coal of $1 per net ton, the profits for any monthly output may be predicted. In the case in point, with 35,000 tons output and a profit of 15 cents per ton, the total profit will be $5,250. Likewise, the total profit or loss for various monthly outputs from this group of mines has been figured as follows:

Tons	Profit	Loss
35,000	$5,250	
30,000	3,720	
25,000	1,575	
21,000		
20,000		$ 400
15,000		2,700

It is thus evident that a decrease in production from 35,000 to 21,000 tons output (40 per cent.) causes a loss of $5,250, while a reduction in output to 15,000 tons causes a loss of ($5,250+2,700) = $7,950 which on the actual tonnage produced amounts to 53 cents per ton lost because of such reduction in output.

Curves Showing Loss Due to Decreased Output.—These results are shown on Fig. 2 in another way by a curve which gives the loss in terms of cents per ton of coal actually produced caused by any percentage reduction in output from the full maximum mine capacity.

As in the other cases, this curve, too, applies only to the particular mines in question, but is nevertheless typical of the accumulative effect of reduced output. Similar production-cost curves can be prepared for any mine or group of mines and will indicate similar results.

The direct loss caused by reduced output definitely shown by these curves is accompanied by other losses of an indirect nature, but perhaps even more serious. For example, the effect of reduced output upon the following items has yet to be considered: Store profits and rentals, and especially upon labor.

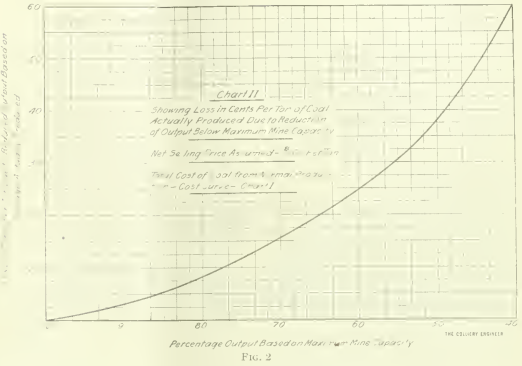


Fig. 2

Indirect Losses Due to Decreased Output.—The return from investment in store stock and equipment is naturally decreased practically in proportion to the reduction in output, while the cost of store management is approximately constant. Likewise the income from rentals of houses depends directly upon the output, since the occupants will not remain long where work is irregular. This is generally true even if conditions are no better at other mines, in which case labor keeps continually on the move. In other words, income not only ceases from unoccupied houses but such houses deteriorate far more rapidly than otherwise.

Effect of Reduced Output Upon Labor.—In all productive industries the most important factor is, of course, labor. But in the mining of coal the labor factor is more important than in any other form of employment. Anything that disturbs labor at a mining plant disturbs the industry at the very bottom. In the vicinity of a coal mining plant there is only one kind of employment and the laborers' income depends solely upon the amount of coal mined and shipped. When production ceases or is reduced, just to that extent exactly the laborer must become idle and to that extent does his income cease.

Consequently the satisfactory wage to the miner, the living wage, depends largely upon regularity of output. For example, it is probably better for the final good of the miner to work full time at 40 cents per ton than half time at 80 cents. But it is infinitely better for the miner to work full time at any scale than half time at the same scale per ton. In the coal mining industry more truly than in any other, the laborer must have a living wage which comes from the employing industry, since he cannot turn to any other occupation. This situation is further aggravated from the fact that he is necessarily a renter, not a home owner.

Any cause, therefore, that reduces or makes the coal mine output irregular eventually increases the scale that the operator must pay in order to enable the miner to obtain the living wage.

Thus, in addition to the direct loss shown on charts Fig. 1 and Fig. 2,

any reduction in output causes an additional large indirect loss both to the operator and to the mine laborer.

Car Shortage the Most Serious Cause of Reduced Output.—The most serious factor in causing reduction in output at coal mines is universally recognized as car shortage. There is likewise an increasing tendency to make claims upon the railroads for the losses thus brought about. There is not the slightest doubt in the world but that an increase of 25 per cent. in production on an average from the mines of West Virginia, due to a better and more regular car supply in addition to the large saving brought the operator, would be as beneficial to the miner as a 25-per-cent. increase in wage scale. The converse of this, that is, a decreased mine output due to irregular and insufficient car supply, equal to 25 per cent., is practically as serious as a 25-per-cent. reduction in wage. Here then is one common ground where operator and miner can and should get together in demanding a remedy for the conditions in the coal mining districts intolerable alike to both, due to the inefficiency of the railroads and their incapacity to furnish transportation facilities.

Actual Figures Showing Car Shortage in West Virginia During 1911 and 1912.—During the years 1911 and 1912 at the group of mines from which these data have been obtained, the car supply has been about 80 per cent. of the easily possible mine capacity after allowing for decreased output due to other causes. This then should represent the supply to all mines served by that railroad. For another group of mines on another railroad our best information indicates that the actual tonnage reduction due to car shortage is about 40 per cent. The actual loss of time during a recent normal month at a group of mines on this railroad was 52 per cent. Though actual statistics are not at hand, they will doubtless indicate that the reduction of output of all the mines in West Virginia due to failure to supply cars amounts to fully 25 per cent.

Money Waste Due to Car Shortage. The money waste due to car shortage can be arrived at as follows: On the assumption that the capital invested in mining plants is equal to the annual tonnage capacity of the mines of West Virginia (a low estimate), say $84,000,000, where $63,000,000 would be a sufficient investment with full car capacity, we have the difference or $21,000,000 of the mine operators' money absolutely wasted.

Operators' Capital Now Made Useless by Lack of Transportation Would Purchase Equipment for 100-Per-Cent. Car Supply.—Curiously enough this excess capital ($21,000,000) belonging to the mine operators made useless by car shortage would be fully enough to purchase the necessary additional equipment required to handle the 21,000,000 tons of coal which the mines of West Virginia can produce but which the railroads cannot carry.

Seventeen thousand five hundred 50-ton cars at $1,200, at two trips per month, and 290 locomotives at $16,000, would handle this 21,000,000 tons of coal and would cost about $25,000,000. In other words, it appears that the mine operators could practically afford to purchase the necessary equipment for the railroads to enable all the mines to have 100-per-cent. car supply.

Assuming that the figures at the group of mines for which actual data have been given fairly represent the general conditions of the state, we find from Fig. 2 that a 75-per-cent. car supply represents a direct loss of over 11 cents per net ton actually shipped, or about $7,000,000 yearly for the 63,000,000 tons now being produced.

Increased Freight Rates.—Under these conditions therefore with a 25 per cent. present deficiency in car supply the operators of the state could afford to pay the railroads an increased freight rate of 11 cents per net ton, provided, however, that there is guaranteed an absolutely full supply of cars. But an increase in freight rates does not come from the shipper when such increase applies to all shippers and all districts alike. Freight increase necessarily comes from the consumer.

Since from inefficiency, or financial incapacity, the railroads cannot furnish full equipment for handling the coal tonnage offered, a general parallel increase in coal freight rates would doubtless not be opposed by the coal operator provided coupled with such increase there is an absolute guarantee* of sufficient shipping facilities to handle the business offered.

The consumer would pay for the extra equipment required, and the railroads, the mine operator, and the mine laborer as well would together be benefited. However, the railroads should be compelled to furnish cars for the tonnage offered or pay both the operator and laborer in full for the resulting direct and indirect loss.

A New Basis of Allotment.—In special as well as ordinary cases of car shortage, which at times cannot in any manner be prevented, a new basis of car distribution should be adopted. A railroad should at least be obliged to carry all the tonnage offered provided such tonnage can be guaranteed. The minimum tonnage offered for any month in the previous year may be taken as a guarantee of tonnage which must be provided for by the railroads and only the fluctuation beyond this minimum should be considered in car allotment. In other words, the cars available after supplying in full each operation its guaranteed tonnage, should be apportioned among the operations on the basis of their capacity above the tonnage already supplied. In this way an operation producing, let us say, a constant tonnage for some public service corporation, with a tonnage in fact offered long in advance, would have full car supply, since its tonnage has thus been guaranteed in advance. Those operations which have a fluctuating production or market or both should not compel the steady producers to share their just claims upon the railroads in order that they may take care of such irregular and fluctuating shipments.

*It is possible that no better guarantee could be obtained than now given in the present charters of the railroads acting as common carriers, This guarantee has however been of little value to the shipper.

Present System of Car Distribution Exaggerates Market Irregularities. By the present system of car distribution price fluctuations are exaggerated since the regular production of low-priced contract coal is diminished in times of car shortage and the consumer, deprived of this coal, rushes into the market for higher-priced coal to replace it, further exaggerating the already abnormal demand. On the other hand, if the railroad is compelled to supply as many cars to each operation as such operation will in effect guarantee to keep continuously employed throughout the year, and the remaining cars be allotted to take care of the fluctuating requirements, both production and demand will be steady. With this system of distribution the producer could be sure of shipping, and the consumer be sure of obtaining, coal contracted for, contrasted with present uncertain conditions.

The mine operator would be enabled to sell on contract and feel sure of delivering a portion of his production and also feel absolutely sure of shipping a reasonable excess tonnage to take care of the special demands at special prices. Under the present system, car shortage so reduces shipments that the producer cannot supply his contract obligations, and if he lives up to such contracts he has no extra tonnage reserved for special demand and at special prices.

The railroads should nevertheless be compelled to supply the mine operators with cars capable of transporting all tonnage offered except at times of extraordinary demands, say up to 150 per cent. of the minimum monthly tonnage offered.

Full Car Supply Will Greatly Increase the Market for Coal.—The statement is frequently made, erroneously I believe, that the consumption of coal is independent of the car supply and that a full supply of coal cars on all railroads would therefore not increase the coal tonnage hauled and consequently there would be no increased revenue from the extra equipment purchased.

This would perhaps be more nearly the situation if the market for coal produced in the United States were now, as formerly, confined to consumers within her own borders. At present, however, with the completion of the Panama Canal and the generally increasing cost of producing European coal, an enormous consumption of coal in South America, Central America, the West Indies, on the Pacific Coast, in Australia, and in Europe, can be supplied from the United States. In addition, the enormous and increasing tonnage of iron and steel exported represents a correspondingly great coal and coke consumption.

A full car supply would therefore not only make it physically possible for the producers of coal in the United States to greatly increase their output for export purposes but also such increased production would at the same time bring about reductions in cost which would enable coal from the United States, either directly or in the form of manufactured products to still further successfully compete in the export markets of the world as well as with water-power installations at home.

SUMMARY AND CONCLUSIONS

1. Production-cost curves indicate graphically the general necessity for increased output.

2. First half production is expensive while "tail-end" coal is cheap.

3. Reduced output increases cost of coal actually produced and deprives operator of cheap coal not produced.

4. Chart Fig. 2 indicates that loss due to decreased output, on basis of coal actually produced rises with increasing rapidity with reduction in tonnage.

5. Reduced output causes large indirect losses due to decreased store profits and rentals, but particularly by increasing the living wage required by mine labor.

6. Car shortage is the most serious cause of reduced output, frequently causing 50 per cent. decreased monthly output and probably more than 25 per cent. for the coal mines of the state of West Virginia generally.

7. $21,000,000 of mine operators' money invested in plants alone is made useless due to a 25-per-cent. car shortage. This amount would purchase transportation equipment to give shipping facilities equal to 100 per cent. mine capacity.

8. On the basis of exact figures from a group of mines, the actual money loss to operators in West Virginia due to car shortage amounts to about $7,000,000 annually.

9. With full car supply and shipment of 84,000,000 tons of coal from the state, an increase of freight rate of 5 cents per ton would purchase equipment for full car supply on basis of 20 per cent. depreciation.

10. A full car supply would be equally beneficial to operators and laborers alike.

11. Railroads should be compelled to pay in full both operators and laborers for all losses occasioned by lack of transportation facilities.

12. Car allotment should have to do only with the cars available after supplying in full each operation its minimum monthly requirements, as shown by record of shipments.

13. Present system of car distribution exaggerates market fluctuations while the proposed system would have an opposite tendency.

14. The railroads should be compelled to supply transportation facilities equivalent to a certain reasonable percentage in excess of the minimum monthly shipments of the previous year.

15. Full car supply would not only increase coal consumption at home, but particularly enlarge the export business.

Power Used in Anthracite Mines

James E. Roderick, Chief of the Bureau of Mines, in Pennsylvania, gives statistics in the 1911 Anthracite Report from which interesting deductions can be made. From 1902 to 1911 the horsepower developed at anthracite mines has increased from 354,237 to 671,802. The greatest proportion of this increase was underground, and while some of the power was for pumps, electric locomotives increased from 53 to 635.

Safety Gates for Shafts

Automatic Gate Locking and Operating Devices for Protection Against Accidents from Falling Down Shafts

Written for The Colliery Engineer

To prevent shaft accidents at the surface, the D., L. & W. Coal Co. uses a gate of simple construction that is raised or lowered into position before the shaft opening by the cage as it comes to or leaves the surface landing. This gate is shown in Fig. 1. It is a double gate, that is, it is constructed the same for each side of the shaft and is raised by the top of the cage striking against the two wooden crosspieces *a* fastened to both gates.

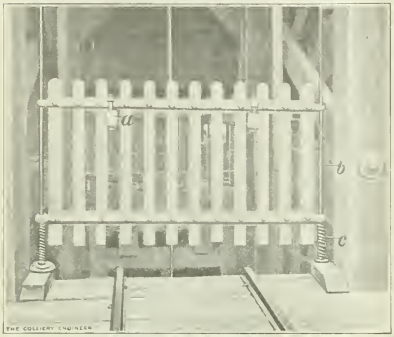


Fig. 1. Shaft Gate Closed

Fig. 2 shows the gate raised. Two iron guide rods *b*, one each side of the gate, keep the gate from swinging or swaying when the cage strikes the cross-beams and also cause it to seat properly. To take up the shock of seating there are two coil springs *c* which answer every purpose. Because the ends are boarded there is no way for a person to fall into this shaft unless he climbs the gates.

Another safety gate is shown in Fig. 3. This gate is used at Pennsylvania Coal Co.'s No. 1 Dunmore shaft where the landing is on a high steel trestle and landers must at times cross the cage opening. The horizontal gate is raised and lowered by the top of the cage and both gates are always over the openings except when one of the cages is at the landing. The shaft collar at the surface of this mine is fenced on four sides and these fences must be removed by some one in authority before a person could fall down the shaft. It will be noted that these gates are worked automatically so that only some one vested with authority to make use of the cage can raise them.

Fig. 2. Shaft Gate, Raised

The shaft gate shown in Fig. 4 is in use at the Strong shaft, Victor, Colo. The bar *B* is made of 4″×8″ timber or of any other convenient size. It is pivoted at *H* by a bolt upon the head-frame leg *A* and at the opposite end fits into the rest or catch *G* of ½ in.×3 in. iron. *F* is a counterweight of the proper heaviness and distance from *H* to permit of the gate being raised or turned on the pivot *H*, by a very light upward pull.

Fig. 3. Horizontal Shaft Gate

Suspended from the bar *B* by means of the rods *D*, *D*, etc. is the lower bar *C*, which may be made of lighter material than *B*. The rods *D*, *D*, etc. are flattened at the upper and lower ends and bolted to both *B* and *C* so that they may turn freely.

Attached to the inner side and on the left end of the bar *C* is a slotted plate of thin iron, through which the bolt *K*, set in the leg *A*, passes.

When the bar *B* is raised by an upward pull near *G* it revolves on the bolt *H*, and rods *D*, *D*, etc., turn on their upper and lower pivots and the plate *E* turns downward on the bolt *K*, the whole gate being raised and folded like a ferry-boat gate.

The gate is very simple, and can be made by any mine carpenter at a reasonable cost.

As gates of this description can be interferred with, the H. C. Frick Coke

Co. have adopted safety catches and locking device.

With the shaft-gate locking device, shown in Fig. 5, it is impossible to open the gate in the railing about the top of the shaft unless the cage is there. The latch can be raised only by a system of levers operated by a handle extending through the fence just beside the gate; and it is only when the cage is in position at the surface that the proper bearing is afforded to the levers so that the latch can be lifted. On the shaft framing at the ground level is fastened a horizontal plate, and an L-shaped lever turns about a pin in this plate. The lever arm is ordinarily back from the shaft out of the way of the cage, but when the cage is present one arm may be turned so as to bear against the side of the cage; the other arm being connected by a straight rigid link to the lower end of an upright lever, to the upper end of which is fastened the rod and handle to operate the gate latch, and which ordinarily when the cage is not present turns about a pin held by a heavy weight about 10 inches from the lower end. If now the upright lever is pulled with the cage away the L-shaped arm is simply turned forward and one arm extends out over the shaft; but if the cage is present, the *L* arm can turn only until it hits the side of the cage when the lower end of the upright lever is prevented from further movement by the rigid link, and the weight is lifted by any further pull. The gate latch is connected by a simple system of levers to this weight, holding the gate locked except when the weight is moved by the lever.

It is proposed to connect this device also to operate a car stop that

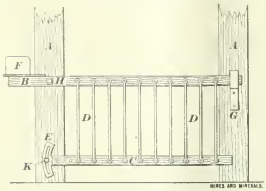


Fig. 4

will make it impossible for a car to run to the shaft except when the gate is open, and the cage in position and ready for the car. The car stop prevents heavy cars from running into the gate.

The D., L. & W. Coal Co. have a combination of a gate which is lifted up by the cage and for a special reason can be made to swing open when the cage is not at the landing. It may be understood that in some instances this double arrangement may be valuable, but as a rule the positive opening and shutting of the gate by the cage will prevent accidents.

In the anthracite fields the gates swing on hinges, and are operated by the lander who opens and shuts the pair on his side of the shaft and by the loader who does the same on his side.

In the mines of the H. C. Frick Coke Co., the bottom of the shaft is shut off from the haulageway by a gate, Fig. 6. This is operated automatically by the cage in such a way that when the cage is not at the landing the gate is there. As the cage approaches the landing it engages a device which raises the gate out of the way. It will thus not be possible for any person to get into the hoisting compartment except when the cage is ready to take passengers.

The arrangement for handling men at some of the shafts is very good, indeed. For instance, at the Leisenring No. 1 there is a waiting room just beside the hospital room near the shaft, the gate to which is locked and the key carried by the cager. As miners are coming from their work at irregular times, the cager allows a sufficient number to gather to make an ordinary cage load, and then unlocks the gate and allows these men to go to the surface. This waiting room is especially important at this mine because of a heavy grade down which the loaded wagons reach the shaft.

A temporary fence is sometimes also provided set some feet from the shaft, and when men are being hoisted not more than one cage load of men is allowed inside the fence at one time, thus preventing crowding at the cage.

⁂

An experimental test on a track near Janesville, Wis., showed that hemlock and tamarack ties put in the track without preservative treatment were decayed after 5½ years service. Those which had been treated were practically as good as when first laid.

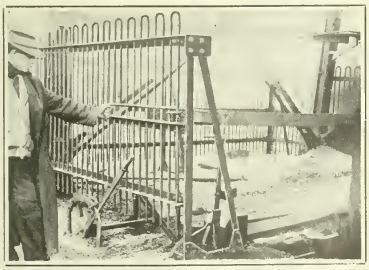


Fig. 5. Shaft Gate and Locking Device

Fig. 6. Underground Shaft Gate

Gasoline Motors in Coal Mines

Conditions Under which They May Be Used—Extent to which They Vitiate the Air—Additional Quantity of Air Should be Supplied

By A. J. King*

THE writer read a paper on this subject at the June, 1912, meeting of the West Virginia Coal Mining Institute, and his purpose in so doing was to bring to the attention of the Institute the advantages and disadvantages of gasoline motors, emphasizing the possible vitiation of the mine atmosphere and suggesting the provision of additional ventilation as a remedy.

The number of gasoline locomotives in use in the mines is increasing and claims of improvement in design are being made by the different manufacturers. It is also claimed that efforts are being directed towards the utilization of leaner mixtures, which will insure a more perfect combustion of the gasoline, though it may result in reduced efficiency.

In a report dated September 12, 1907, upon "Gasoline Locomotives for Mine Use," Jas. W. Paul, Chief of the Department of Mines of West Virginia, as a result of his examination of gasoline locomotives then in use, makes the following remarks:

"The adoption of this motor to work within the coal mines, depends for safety upon the location of the gasoline tank; the efficiency of the carbureter and engine, and the proper ventilation of the mine.

"With the gasoline tank well protected within the frame of the motor, the danger from this source should be a minimum.

"The working of the carbureter will depend upon the motorman having a full knowledge of its construction and the purpose for which it is intended—making a proper mixture of gasoline vapor and air.

"The matter of greatest importance is the proper ventilation of the mine to meet the conditions under which the motor is used.

"To gain admittance to the mines of West Virginia, with the consent of the Department of Mines, the motor will have to be restricted to operation on headings along which the return air-current is traveling, and it shall not be permitted to be used on any heading where less than 10,000 cubic feet of air per minute is traveling, and in no case, except as permitted in writing from the District Mine Inspector shall the motor be used in a current of air which moves onto the workmen in their places."

In November, 1909, the writer, accompanied by District Inspectors P. A. Grady and Bonnor H. Hill, inspected a gasoline motor in service, for the Department of Mines for the State of West Virginia, after which we made the following recommendations:

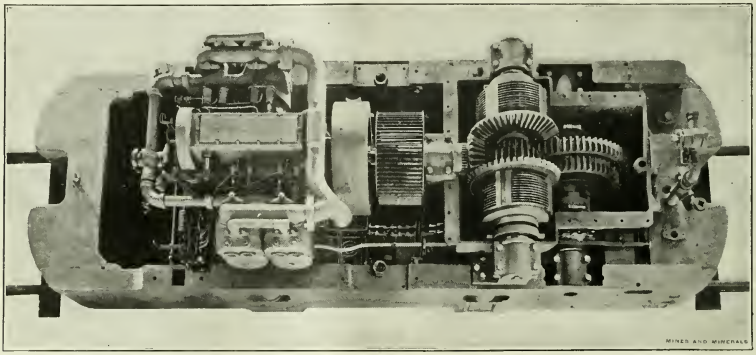


Fig. 1. Top View of Gasoline Locomotive with Cover Off

"First. That in all cases where possible, these motors be operated on a return air-current of a quantity per minute to be determined by the District Mine Inspector.

"Second. That the gasoline tanks be filled on the outside of the mine.

"Third. That the gasoline tanks must not be stored in the mine.

"Fourth. The starting device must be covered.

"Fifth. That the motorman and all others be instruced as to the dangers incident to the handling of gasoline in a mine."

In their general application or adaptability, gasoline motors for haulage purposes are similar to electric and compressed-air locomo-

* Mining Engineer, Charleston, W. Va.

tives, that is, the track arrangements are made and the trips and cars are handled in the same way. Each type, however, has advantages and disadvantages peculiarly its own.

From blasting, respiration of men and animals, the decomposition of carbonaceous matter, and the noxious gases exuding from the coal or the strata above or below the coal, the mine air is being continually contaminated, and the possibility of further vitiation of the air-current should certainly not be disregarded when contemplating the installation of haulage motors.

In the writer's opinion, where gasoline motors are used, a specific additional quantity of air should be provided for and supplied, and care should be taken that this additional quantity of air be applied directly to the dilution and removal of the noxious gases generated.

The following are the analyses of samples of mine air which were taken by P. A. Grady, former District Mine Inspector of West Virginia, 12th District:

No. Sample	CO_2	O_2	CO	CH_4	N_2
1	.07	20.87	.03	.10	78.93
2	.11	20.92	.07	.13	78.77
3	.13	20.80	.06	.32	78.69
4	.09	20.78	.03	.33	78.77
5	.15	20.91	.05	.11	77.08
6	.15	20.86	.07	.10	78.82

Sample No. 1 was taken 80 feet ahead of the air at the face of a room; locomotive in the room 5 minutes with the engines running; 6,000 cubic feet of air passing on the entry; grade 3 per cent. in favor of the loaded car.

Sample No. 2 was taken 80 feet ahead of the air at the face of room; locomotive was run up to face and pulled out a loaded car; grade in favor of the loads 3 per cent.; 6,000 cubic feet of air passing on the entry.

Sample No. 3 was taken at face 210 feet ahead of the ventilating current; locomotive was run up to face, stood there 5 minutes with engines working and came out; fumes noticeable; grade 3 per cent. in favor of the loads.

Sample No. 4 was taken at face 210 feet ahead of the air-current; locomotive was run up to the face where a loaded car was coupled to it and pulled out; time in room was 1 minute; grade 3 per cent. in favor of the loads.

Samples Nos. 5 and 6 were taken in the air-current on the entry; area 15 feet × 5 feet; quantity of air passing per minute, 6,000 cubic feet; locomotive was made to perform hard work running up the entry, which has grade of 5 per cent.

Remembering that these tests were made so as to give very nearly the conditions resulting from the use of this type of locomotive, it will be seen that these analyses show that carbon dioxide (CO_2), carbon monoxide (CO), and marsh gas (CH_4) are given off under all conditions of service, and that these are additions to the noxious gases usually given off by the mine.

A test of the gasoline locomotive in advanced workings, under the supervision of R. Wallace, Mine Inspector, gave the following results:

"On the 19th, 19 cars were pulled and the men became sick; on the following day 19 cars were pulled and men complained of sickness all day; on the 21st the motor was taken to another entry, placed 10 empty cars and pulled 6 loads by 2 P.M., and men complained of sickness; on the 22d, motor was taken to another entry, pulled 20 cars from 7 men; some of the men went home and the others became very sick."

In this case the ventilation was insufficient, the quantity of air passing varying from 5,000 to 9,600 cubic feet per minute.

These tests show the necessity for the provision of ample ventilation, which should be considered carefully, and as a part of the proposition, when the installation of motors of this type is contemplated.

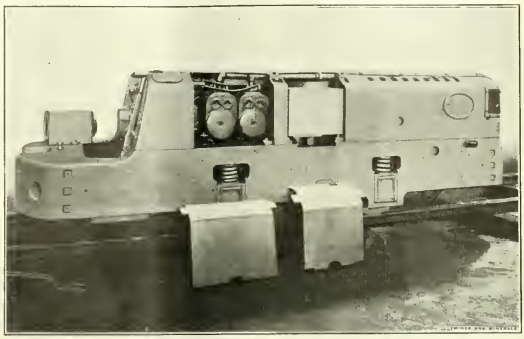


Fig. 2 Locomotive with Gasoline Tank Doors Removed

Where a gasoline motor is operated in the main return air-current, and where it is impossible for the noxious gases generated to pass through the working places, it may, possibly, be done without any serious danger or inconveniences, but it is the contention of the writer that wherever gasoline motors are used in a mine, additional air (say 1,000 cubic feet per minute per ton weight of locomotive, or 10 cubic feet per minute per rated horsepower of the engine) over and above the usual quantity, should be provided. And we do not think that the quantity of additional air required for the ordinary mine, figured on this basis, is at all prohibitive.

With the danger from the deleterious gases removed, this type of motor has many advantages over any other in use.

Practical Mule Haulage

Conditions Under Which Mule Haulage is Economical—Care and Management of Mules and Drivers

By A. E. Thompson*

MULE haulage in coal mines is a matter to which special attention should be given. Its practicability and economy are largely governed by the natural conditions of the seam to be operated. Seams with considerable inclination or dip are not so well adapted to this system of haulage as those lying level or nearly so. Long mule hauls are not usually profitable in coal mining. If the main haulage is driven down the pitch and the side entries turned across the pitch, the rooms must be turned off the side entries or cross-entries driven up the hill and the rooms turned off them across the pitch. Where the first-mentioned system is used the empties must be delivered to the face of the rooms, and, if there is much grade, the loads dropped out. This system necessitates long rooms and a considerable loss of time in gathering the production; and where the development is extensive, and there is no mechanical haulage in the side entries, a long mule haul is required to deliver the coal to the main haulage. When the cross-entry system is used, the empties must be pulled up the hill and the loads drawn by strong teams down to partings on the side entries, to be delivered to the mechanical haulage. This requires more mules and more drivers in order to get the production to the main haulage road. It is a poor system from an economic standpoint, is not practical and should not be used where mechanical haulage can be installed.

In level seams, or seams which are nearly so, mule haulage is more practical. The system of operation can be such that both side entries can be used as haulageways, thus keeping the drivers gathering to the same partings on separate roads and avoiding the liability of one driver stopping all the production in that section in case his trip of cars should be derailed. Where mule haulage is practicable and economical, the haul should be kept as close to the minimum as possible, for this system ceases to be economical when several drivers are hauling coal over the same road, because cars become congested and much time is lost by drivers waiting for the right of way. The mechanical haulage should be kept extended so as to avoid this congestion and keep the mule haulage down to the minimum.

Careful management is essential to successful mule haulage. In large operations a boss driver who is thoroughly familiar with the system or systems in operation should be employed. The individual drivers also must be considered, for without level-headed operators no system can be efficient. When you see a driver who goes into the mine with only one thought, and that quitting time, you will find him an expensive man. He will be thoughtless with regard to his work, will use sprags on his mule instead of a whip, his mule will be poorly cared for in the mine, his harness out of repair, and the men from whom he gathers coal will be constantly dissatisfied with his service. Some of the miners will have twice as many cars furnished them as others because they are nearer the parting and their coal can be gathered with less trouble to the driver. Such a man will delay the game at every opportunity. Unfortunately, this type is found to some extent in all mines and it is essential that they should be weeded out, or sooner or later they will spoil the other drivers. On the other hand, a driver who is always in the collar, and always trying to get out another car of coal, helps keep down the cost of your mule haulage. He takes care of his mule, keeps the cars evenly distributed among the men on his haul and, consequently, keeps everything on the move—he has an interest in his work.

Good roads are necessary to mule haulage. The mine roads must be kept in good repair; the tracks should be well cross-tied and kept clean to the top of the ties; switches should always be protected so that the mules will not catch their hoofs in frogs and be crippled; sand rails should always be provided on heavy grades in order to keep the cars from running into the mules. Where rooms are turned to the dip, care should be taken to see that the curves of switches are not so short that the cars will be pulled into the rib by the mules in hauling out of the dip rooms. Avoid dirty and dusty roads—they not only hinder the production but are a source of danger. Neither the mules nor the men can do the maximum amount of work if the mine air is heavy with coal dust. Mine managers should not forget that dirty and poorly kept roads are a great drawback to the production and, as we are governed largely by the cost sheets, it is essential that production be kept as near as possible to the maximum. Every ton added to the daily production by means of well-kept roadways helps materially in keeping the "red ink" off the cost sheets.

The mine mules should have proper care both in and out of the mines. This can only be assured by putting competent men in charge of mule barns and having a good, practical boss driver who will see that the mules receive proper treatment and care inside of the mines. Each mule should be well fed, but care must be exercised to see that they are not overfed. It is the duty of the stable boss to acquaint himself with the habits of each individual mule under his care. He should be familiar with the amount of feed that is required to keep each mule in the best condition. At feeding times I have frequently seen stablemen give each mule the same amount of grain, regardless of the amount of work done by the animal, or its condition. Examine the feed troughs or mangers

*Mine Inspector, Victor-American Fuel Co.

after the mules have been taken out to work. In some cases a half, more or less, of the grain will be found; in other cases the troughs will be entirely empty. This examination by the barn boss invariably leads to economy in the feed bills.

At our mines we employ veterinary surgeons who make regular visits from time to time and give general directions as to the care of the mules, as well as in response to emergency calls. Their general directions will not, of course, apply to all of the mules in the barn, but our stablemen take it for granted that they must be adhered to in all instances. This is not right. Each mule has its own individuality and peculiarities, which must be found out by the barn boss in order to get the best results, because what will be good for one mule will not be best for others. This does not imply that the veterinary does not know his business, but it is true that as a general rule he does not know his men, and perhaps for this reason, as much as any other, his orders are often misinterpreted by the stablemen.

It should be made a rule to feed and water the mules regularly. If possible, they should be watered at noon time in the mines, and if feed is also provided at noon their efficiency will be increased. Where stables are located on the surface they should be warm; and stables, wherever they may be, should invariably be kept clean and dry. The stablemen should see to it that all harness leaving the barn is in good repair, that every collar is well cleaned, and that each mule has a collar of the proper size. It is the business of the boss driver to have a supply of spare harness parts kept on hand in the mine so that any breakage can be quickly repaired. Spare tail chains, spreaders, and pins should be kept on all partings, so that they may be at hand in case of breakage during the shift.

Pay special attention to the cars where mule haulage is extensively used. To get the best results the cars must be kept well oiled and in good repair or they become a very expensive item in the production. Cars for mule haulage should be of medium size, but this is a point which will be governed largely by the height of the coal seam to be operated. In my experience I have found that cars from a ton to 3,000 pounds are the most advantageous for mule haulage. Such cars are easier kept in repair and easier to rerail after a derailment, as the driver ordinarily will be able to handle the empty cars alone.

Provide all cars with brakes, but, and consider this carefully, the brakes must be kept in good repair. In many mines I have found the cars provided with brakes but the majority of them were out of repair and practically useless. Mine managers and mine foremen must pay particular attention to this item, otherwise they are adding dead weight to their equipment. With the brakes on cars kept in good condition, almost any man can take the place of a driver for a day if the shift is short-handed. If, however, cars are not provided with brakes and sprags have to be used, it is difficult to get a driver from among the men. They are not used to spragging and are liable to cripple a mule through their inability to sprag, thus allowing the car to catch the mule, particularly where tail chains are employed and there is any grade to descend. Always keep in mind that a crippled mule runs up your cost of production. Where there is much grade to contend with shafts should be used as there is less liability of having mules crippled in the descent of grades by being caught with trips. If brakes are used the chance of accidents to the mules is reduced to the minimum. Where the seam is level and there is little spragging to do, tail chains can be used to advantage, because the mule can be more quickly attached to the cars and less time is required to gather the coal. Our own experience is that we have fewer practical drivers than was the case a few years ago, consequently greater precautionary measures for the protection of both the mule and driver are essential.

The Leasing of Mineral Lands

*By William Griffith**

Reformers, or so-called conservationists, in their recent efforts to secure or conserve for the people a greater share of the proceeds of the mining enterprises on the public lands, have fixed upon the leasing method as the one best adapted to secure this end, and hope to substitute it instead of fee simple sales. They would distribute in various ways for the public good the royalties arising from such leases, and so avoid the chance that an increased market price for the products might result eventually in an unduly small royalty, they would require short tenure leases, that the royalty might be from time to time changed as the market value of the product varies, and thus reserve for the people a more equitable share of the proceeds; and all for the purpose of aiding the laws of conservation.

We respectfully submit, however, that this proposed plan of short tenure lease is unsatisfactory, impractical, and one of the most wasteful that could be conceived. It has been abundantly proved, during the hundred years life of the coal industry of Pennsylvania, during which all sorts of titles have been held, that the short-term lease is exceedingly wasteful and non-conservative in its tendencies. The results of experience throughout the mining and industrial worlds prove that there is an economic law governing these matters, which must be recognized by all conservationists everywhere; viz., short tenure tends toward small operating units, careless methods, extravagant waste of national resources, with excessive loss of human life; while long tenure promotes large operating units, careful and scientific methods, with the greatest possible conservation of life and property. The courts in many of the states have declared over and over again that a perpetual lease, that is to say, in case of a mining property, a lease until all the mineral in the land is exhausted, is a sale, the royalty being payments

* Scranton, Pa.

on the instalment plan. If, therefore, it is determined that the public lands of this country shall be leased, the proper sort of holding would be a perpetual lease, so called, or as near approach to it as may be possible; not less than 50 years—unless the mineral is sooner exhausted—with rights of renewal. In order that the royalty may fit the fluctuating physical and market conditions, it should be arranged on a sliding scale, automatically adjustable—a percentage, if you please, of the market value of the product, thus obviating the necessity of frequent changes of lease and royalty. There are a number of reasons why titles held on this plan are very advantageous, some of which we will briefly enumerate below:

A perpetual or long-term lease is advantageous for the lessor or owner, and for the lessee, whether prospector or operator. It is best from the viewpoint of the financier. It tends to the greatest conservation of resources and human life. It is best for the people, and tends to reduce speculation.

It is best for lessor:

1. Because it tends toward large operating units, induces permanent equipment, and is attractive to substantial experienced operators.

2. It tends toward the greatest conservation of the raw material and the least loss of human life, through the introduction of scientific and workman-like methods and life-saving devices, resulting in a greater output and larger returns of royalties, and is consequently more remunerative to him than an outright sale.

It is best for the lessee:

1. If a prospector, it encourages exploration, discovery, and development, and would secure to him a sure reward with the least outlay, for if he shows a good prospect his lease is more salable than a fee-simple title, because there is less money at stake and less hazard on the part of the purchaser.

2. If a lessee is an operator, it is best for him, because the money which he would otherwise invest in a fee-simple title may be used to prove the property, and if found good, to develop and equip. He thus secures the property on its merits, and can regulate his investment accordingly. If the developments show the property to be worth it, he will be warranted in installing substantial equipment, and his title affords suitable security upon which, if desired, to borrow the necessary capital. If his provings show the property to be unsatisfactory, he may forfeit his lease, and thus save what would otherwise be lost through purchase of the fee-simple title.

Next to the fee-simple title, a perpetual lease is the best from the viewpoint of the financier, because it tends toward more substantial permanent equipment, larger outputs, and profits, thus affording better security for loans, and permits long-term bonds which are more attractive to investors. Short-term leases or contracts, subject to changes at renewal periods, are poor security, and cannot be easily financed.

From the conservationist viewpoint the perpetual lease is preferable:

1. Because the lessee expects to exhaust all the coal, and therefore conserves the supply for the future by avoiding waste in mining, and to secure this end, can afford the expense necessary to install permanent, up-to-date plants, use the latest and best mining methods, employ competent engineering advice and means for preserving the lives and comfort of employes.

2. It is to the advantage of the operator for conservation purposes to experiment with and investigate new methods of mining and utilizing his production order to make a market for inferior portions of the ore or coal which might be otherwise wasted.

3. The quantity of ordinary waste or refuse material from large plants is so great that its possible value becomes an item of considerable importance, and is worth the expense of searching out new methods for its utilization and conservation.

Perpetual leases promote public welfare, because:

1. They will stimulate prospecting, and the discovery of new coal or mineral areas.

2. They hasten developments more rapidly than any sort of title.

3. They will produce revenue for school and territorial purposes.

The leasing method is not advantageous for the speculator in lands or mines, because his profits would necessarily be smaller than in case of sale of fee property, for the purchaser must pay twice; first, as a profit to the speculator; second, as royalties to the lessor.

The above general principles would seem to be universally applicable, and to apply with double force to the coal lands of Alaska, because the best coals of the territory are high-grade only because of their proximity to the volcanic rocks, and are therefore liable to be much broken, folded, or crushed through the movements or quakings common to eruptive measures.

On account of the unfavorable physical conditions, added to the high cost of labor and material, and lack of transportation facilities, the preliminary expense of properly proving Alaska coal lands for the operator will be unusually large. This must be done, however, before he is warranted in making the investments necessary to equip a mine plant. How much better, therefore, it would be under these circumstances if land could be purchased on its merits, by this instalment plan, instead of first hazarding the cost of a fee-simple title, which might ultimately result in a dead loss. Under the perpetual lease the rights of the prospector or operator may be well protected, and he is at all times posted as to the probable value disclosed by his development work, and may regulate his investments accordingly, without first being required to gamble on a fee-simple title.

The long-term lease is a very popular method of handling coal properties in the eastern United States. It is favored both by the land owner and by the operators. In fact, most coal operators would choose such a title in preference to investing so much of their capital in land purchases; but no one favors the short-tenure lease. The coal land

owner, as the result of dire experience, views it as the most ingenious device ever instituted for the purpose of wantonly wasting his substance, and the operator regards it as a delusion and a snare. It deludes him with the pleasant but often-mistaken notion that he can pay out the investment with large profits before his short lease expires, and it becomes a snare when he gets in financially, and then finds that he can't get out.

The Protection of Pit Ponies

Written for The Colliery Engineer

The large number of accidents which have occurred to pit ponies and mules in the course of mining work has drawn attention to the necessity for some form of protection for the heads and eyes of these animals, and some very interesting forms of skull caps and eye guards have been recently devised. One of the most useful forms of head-gear for this purpose is shown in Figs. 1 and 2, it being made to conform with the requirements of British Mines Act dealing with this subject. The skull cap is adjustable to fit any horse, the eye piece being formed of aluminum, blocked to a dome shape and covered back and front with leather. In this way it forms a guard for the eyes and at the same time gives free and unobstructed vision. This light and strong form of construction combines comfort and efficiency in the highest degree. In some other kinds of head-gears which have been introduced mishaps have occurred to the ponies owing to the breakage of wires and rusting of plates, but in this head-gear there is no such danger. The eye piece is padded inside, and in the event of accidental collision, inasmuch as there are no wires in its construction, there is no risk of chafing or injury to the head or eyes. The bridle is constructed of the best harness leather, great care being taken to insure high workmanship and finish. It will be seen that it can be adapted to any bridle which is in use, although it is advisable in order to insure complete fitting that the whole head-gear, eye guards, and skull cap should be supplied in one piece. The arrangement is adjustable and will fit any size of pony from $12\frac{1}{2}$ to 15 hands, and in comparison with guards containing wire mesh or perforated iron plates, distinctive advantages are offered. In the first place

Fig. 1. Head Protector

Fig. 2. Horse Wearing Head Protector

with wire-mesh guards there is a risk of the wire breaking in collision with rocky walls, and if perforated iron plates are used there is obstruction of the animal's vision. The use of aluminum prevents rusting and the form of eye opening gives the pony perfect sight within a wide range. It is being adopted not only in the Scottish coal fields, but it is also under trial in many parts of England and Wales, with satisfactory results.

A single mill in Maine uses 2,000 cords of paper birch each year in the manufacture of toothpicks.

Prevention of Haulage Accidents

Miners Circular 11 of the United States Bureau of Mines deals with accidents in mines caused by mine cars and locomotives. It was prepared by L. M. Jones, one of the mining engineers connected with the Bureau, and should be in the hands of every man in any way connected with mine haulage. He gives advice on traveling in haulage roads, riding on mine cars, moving cars in rooms, placing props near tracks; also makes suggestions to the driver on car riding, spragging cars, applying brakes, handling mules, etc.

He suggests to the motorman certain precautions to be observed if he would decrease the number of accidents, and he advises brakemen and trip riders what to do and what not to do.

The hooker-on, the topman, the fire boss, and the foreman are instructed how to prevent haulage accidents. Recently Mr. Jones supplemented this circular by a paper prepared for the Alabama Coal Operators Association, in which he analyzes the number of haulage accidents and assigns them to various causes and then suggests remedies for their decrease.

In a table he gives the total number of fatal accidents, the number which occurred through haulage arrangements, and the percentage of haulage fatalities to the total number as follows:

Year	Total Number	Haulage Accidents	
		Number	Per Cent.
1910	2,840	476	16.76
1911	2,719	438	16.11
1912	2,360	430	18.22
1913 (5 months)	985	200	20.30

In Alabama, in 1912, there were 121 fatal accidents. Of this number 12 were killed by mine cars, two by rope haulage appliances, and three by railroad cars outside.

The percentage of the total killed by haulage arrangements is 14 per cent. of the whole, which is 4 per cent. less than the average throughout the country. Most of the accidents oc-

curred in entries, although some occurred in rooms. His remedies are the same as those suggested years ago by mine inspectors and adopted by numerous coal mining companies in the United States.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Steel Mill Buildings, by Milo S. Ketchum, 556 pages, illustrated, $4 net. McGraw-Hill Book Co., New York City, publishers. Probably no book in recent years has been written so clearly on constructive engineering as this one by Professor Ketchum. It is a book that should be in the library of every architect and engineer. The author in an unusually clear way has calculated the stresses for every conceivable load, both by algebraic and graphic methods.

Graphic Statics of Roof and Bridges forms Part II in the volume. The designs of mill buildings from the footing of the foundation to the style of roofing is interestingly set forth. An appendix gives structural drawings, estimates, and designs, concluding with a chapter on tables and structural standards.

Improved Methods of Connecting Small Turbines in Steam-Power Plants and Exhaust Heating and Drying Systems, is the subject of a booklet distributed by the DeLaval Steam Turbine Co., Trenton, N. J., in which are described several methods of connecting small turbines for driving auxiliaries in large steam-power plants, also in connection with exhaust steam heating and drying systems in isolated plants.

The Cyanide Process, by James Park, Professor of Mining in the University of Otago, has reached its fifth edition. The original scope of this little book, when first issued in 1894, was that of a practical manual. Since then there have been so many changes the book has been enlarged with each edition, the fifth containing 108 more pages than the fourth. There are 15 chapters with index, 20 plates, and 19 wood cuts. Charles Griffin & Co., London, England, are the publishers. While the book gives little of the American practice, it retains much of the earlier practice now obsolete for the purpose, the author states, of its educational value. It seems a pity that he has not been more in touch with American filter-press practice, and the wonderful work done with it in South Dakota, Canada, Mexico, Nevada, California, and Colorado.

Igneous Rocks, Volume II, by Joseph P. Iddings, is an imposing book containing 685 pages, 20 figures, 8 colored maps, and over 2,000 chemical analyses of rocks. It is published by John Wiley & Sons. Price $6 net.

The author in his preface seems to be pessimistic on the subject of igneous rocks, but after seeing the mass of information he has accumulated and placed in his book he will be forgiven. The book is divided into two parts.

Part I is subdivided into six divisions: (1) Rocks with Preponderance of Quartz; (2) Rocks with Quartz and Feldspar; (3) Rocks with Feldspar and Little Quartz; (4) Rocks with Feldspars and Feldspathoids; (5) Rocks with Feldspathoids; (6) Rocks Chiefly Mafic Minerals.

Part II is on the occurrence of igneous rocks.

The History of the E. I. duPont de Nemours Powder Co. A Century of Success. Published by *Business America*, New York, is a highly illustrated book of over 200 pages. It starts with the origin of gunpowder, the first use of arms, ammunition, and explosives. It states that the manufacture of powder has been, as it were, a public trust, for in the first authentic record in Europe, under date of 1326, it appears that the making of explosives was delegated to the supervision of a State Council.

The book contains a history of the duPont family, the first powder mill in America, on the Brandywine; legitimate commercial evolution; the use of dynamite as a farm necessity in subsoiling; the testing of all forms of explosives and detonators; the relations of the company and their workmen; and smokeless and the sportsman's powder; concluding with chapters on the present combustion development work. The book is bound in fabrikoid, a heavy serviceable by-product resulting from the manufacture of explosives.

Explosives

Department of Commerce advance sheets on explosives manufactured in 1909 has some interesting figures concerning their production.

Explosives which are intended for use in coal mines where there are inflammable gases and which have passed the prescribed tests of the United States Bureau of Mines are designated as "permissible explosives." These explosives were reported separately for the first time at the census of 1909. Generally they are similar in composition to dynamite, and such quantities as were manufactured in 1904 and 1899 were reported as dynamite. The aggregate production of dynamite and permissible explosives in 1909 by establishments engaged primarily in the industry was 204,763,299 pounds, valued at $19,562,955, as compared with 130,920,829 pounds, valued at $12,900,193, in 1904, and 85,846,456 pounds, valued at $8,247,223, in 1899, an increase for the decade of 138.5 per cent. in quantity, and 137.2 per cent. in value.

In 1909, 44 establishments reported the manufacture of nitroglycerine, 25 the manufacture of dynamite, and 13 the manufacture of permissible explosives.

The production of gunpowder and blasting powder in 1909 aggregated 246,339,875 pounds, valued at $11,344,692, as compared with 215,820,144 pounds, valued at $8,919,460, in 1904, and 123,314,103 pounds, valued at $5,310,351, in 1899. The manufacture of blasting powder was reported by 38 establishments in 1909, and that of gunpowder by eight establishments.

HAULAGE, BY THE MANUFACTURERS

Efficiency in Mine Haulage

By W. H. Bines*

A man prominent in the coal business said that coal mining nowadays was largely a problem in transportation. When one considers the distance from the tipple some mines are situated and the extent of the underground workings, this is not a vastly exaggerated statement.

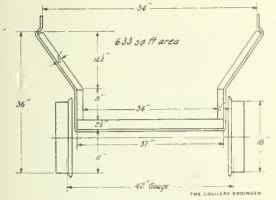


Fig. 1

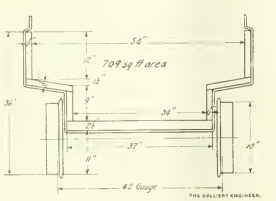


Fig. 2

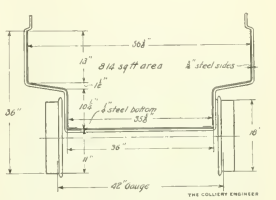


Fig. 3

This problem in transportation consists of two parts: laying out the best plan of trackage, and choosing the best rolling stock to get the lowest cost per ton of coal mined. The plan of trackage varies with every locality and does not come within the scope of this article. The cars used also vary widely but, in selecting them, there are three principles to be considered which apply to all mines.

To gain greater efficiency in your haulage you can:

1. Increase the weight of the coal hauled in proportion to the weight of the car containing it.

2. Decrease the amount of drawbar pull due to friction.

3. Decrease the delay due to derailments and wrecks and increase the number of cars hauling coal in proportion to the number in the repair shop.

Discussing the first, very few mines use cars of as great capacity as they might. Admitting that there are a few that use cars too large to load or handle easily, the statement is still true, and these are the exceptions that prove the rule. A great many mines use cars like Fig. 1. This car has, in the dimensions shown, a sectional area of 6.33 square feet. By changing the shape to that shown in Fig. 2 an area of 7.09 square feet, or an increased capacity of 12 per cent., is obtained without increasing the outside dimensions and with an increased weight of less than 4½ per cent. in the car. By using steel cars a sectional area of 8.14 square feet is obtained, or an increased capacity of 15 per cent. over Fig. 2 or 29 per cent. over Fig. 1, with a total weight increase of 11 per cent. Now suppose that the mine motors have a haulage capacity of 40 tons or 80,000 pounds and that, with mine cars built like Fig. 1 the gross train weight is made up of 47½ per cent. cars and 52½ per cent. coal, then with cars like Fig. 3, the gross train weight would consist of 44 per cent. cars and 56 per cent. coal. This would give 6½ per cent. more coal at exactly the same expense for haulage. If, as in some Illinois mines and others equipped with shafts, the number of hoists that can be made in a day is limited by using cars designed like Fig. 3, the daily capacity can be increased 15 per cent. over cars like Fig. 2, or 29 per cent. over cars like Fig. 1, with very slight additional cost for power used in hoisting.

The second method, as stated, consists of reducing the drawbar pull due to friction. Recently the use of roller bearings for this purpose has received unusual consideration. It is well known that the frictional resistance in mine haulage is generally between 1 per cent. and 2 per cent. and averages slightly below 1½ per cent. This has frequently been reduced to one-half per cent. by the use of roller bearings. However, roller bearings are not the sole method of accomplishing this. The use of brass journals or of brass-bushed wheels will cut the friction in two and have the added advantage of being much simpler and longer lived. The use of spring draft gear to reduce the heavy starting load has more importance than is generally recognized. A motor cannot haul more cars than it can start, and cases are on record of starting 50 per cent. more cars with spring draft than with solid bumpers. Besides this, spring draft adds materially to the life of a car through reducing shock. The general design of the car itself has an important bearing on the amount of frictional resist-

*Chief Engineer, The Watt Mining Car Wheel Co., Barnesville, Ohio.

ance. For instance, a car may have roller bearing wheels, spring-draft gear and all such refinements, and because it has been built with too

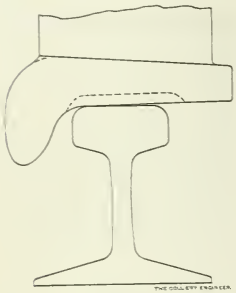


Fig. 4

short a wheel base the flanges of its wheels will bind on the rails on curves and cause a braking action that will more than overcome the good derived from its wheels, etc. But for the purposes of argument, assume that by the use of these various methods the resistance is reduced from 1½ per cent. to ¾ per cent. and that the maximum grades are 4 per cent. Then, with the old type of wheels there is a total resistance of 5½ per cent. against 4¾ per cent. This would be a gain of 16 per cent. and would enable one who had formerly been hauling 20 cars, to haul 23 without any additional power. The common statements that roller bearings will double the number of cars in a trip are only true on perfectly level and straight tracks.

The third factor that cuts down output is wrecks, for two reasons: first, the delay on the haulage roads; second, the number of cars that are in this manner taken out of service. Suppose the derailment only takes 10 minutes to replace. This is 2 per cent. of a 9-hour day. Most wrecks take from 1 to 3 hours to clear up, or 11 to 33 per cent. of the working day. Suppose there are 300 cars in the mine and 6 are disabled by the accident. This is 2 per cent. of the carrying capacity. Granted that the track is in good shape, the commonest cause of derailments is defective wheels, although defective drawbars or couplings, or brakes, cause their share. However, the trouble with drawbars, couplings, brakes, etc., is usually faulty material, insufficient size of material, or lack of care and attention. But wheels are more often defective in design. A proper section through a wheel tread and flange is shown in Fig. 4. This shape chills properly, is proportioned to support the load and resist the strains on the flange due to rounding curves and striking frogs at high speed; it centers properly on the track and avoids the friction caused by the flange rubbing on the side of the rail head. A poor shape is that shown in Fig 5, as there is too much iron opposed to the chilling at the angle where the tread and flange meet. This results

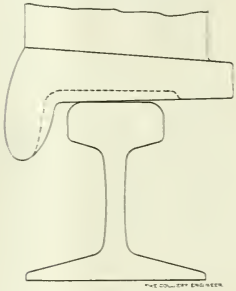


Fig. 5

in a poor chill or none at all at this point. The wheel wears away as shown by the dotted line leaving the flange very thin and easily broken. On Fig. 4 the wear will be slower, owing to the better chill, and because of the shape of the flange, it will wear in the manner shown by the dotted line and not reduce the thickness of the flange. Owing to the sharp corner and almost vertical face of the flange, the head of the rail hits a flange like Fig. 5 a direct blow, while on Fig. 4 the blow is a glancing one on the slope. On account of the long curve on Fig. 4 the wheels automatically center themselves on the track and are less likely to run off at a slightly misplaced frog or a low joint, while on Fig. 5 the flange can run so close to a frog that is a little out of line that it easily climbs over. And finally, this very fact that the flange on Fig. 5 can rub the side of the head of the rail creates additional friction and increases the draw-bar pull. If broken flanges can be avoided it is safe to say there will be but half as many derailments.

Advantages of Steel Mine Cars

*By G. P. Blackiston**

Mine cars cannot, like railroad cars, be constructed on standard specifications, for the width and height of the entries in coal seams are variable.

A mine car should have the largest capacity possible for given outside clearance, and the lowest possible weight per unit of carrying capacity. The strength of the cars is also an important consideration. The cars should have the lowest possible frictional resistance when being hauled, low cost of maintenance, freedom from necessity of repairs, long life, and low cost.

Steel construction is peculiarly adapted to meet these conditions. Compared with a wooden car, our cars have 10 to 15 per cent. greater capacity for the same outside dimensions. Accidents that would destroy a wooden car, would not damage a steel car at all, and steel cars, having no bolts to work loose or wood to decay, do not get out of shape and do

Fig. 1

not permit the running gear to get out of alinement.

Repairs and maintenance average less than 25 per cent. of the cost of

*Oppenstein-Arthur Koppel Co., Koppel, Pa.

wooden cars. This means that no excess equipment is needed, as all the cars will be in use instead of the repair track being full of idle cars.

The life of the steel car has not yet been determined. The Orenstein-Arthur Koppel Co., state that some of their steel cars have outlived several generations of wooden cars and are still in good condition, and that considering life, and low expenditure for maintenance, the cost of a steel car is very much lower than that of a wooden car.

From the first, they have aimed to develop designs which were suited to the material used and to bring into action the great strength and durability of steel and have equipped their shop with the special machinery needed for this purpose. Fig. 1 shows a typical steel mine car, and their engineering department will furnish, upon request, designs for cars of the proper capacity and dimensions to suit the special needs of any mine.

Hyatt Roller Bearings Applied to Mine Cars

*By J. A. Schroeder**

Due to the construction, the Hyatt rollers and bearings are exceptionally well suited for use in mine cars. The rollers in the Hyatt bearings are hollow, flexible spirals, being wound cold from flat strips of steel. They are mounted in cage rings held together by spacer bars. Thus in handling the bearings, there are no parts to become loose or get lost. The rollers are made of chrome-nickel steel, heat treated and ground. A planished sheet-steel lining is furnished, which fits into the bore of the wheel or the box, providing a suitable outer raceway for the rollers. This lining has a V-shaped opening or slit, making its mounting very easy.

Due to the flexibility of the rollers, these will withstand the severe shocks to which a mine car is subjected, and not only is crystallization of the rollers themselves thereby prevented, but the rollers will to a great extent act as shock absorbers for the entire car. The rollers being hollow, each roller is a natural oil reservoir and in traveling around the axle it will pick up its quota of oil. The oil is then distributed over the entire bearing surface through the spiral grooves, and these being alternated right and left hand, the entire bearing surface is always lubricated. This feature is very valuable as the Hyatt bearings will run a long time without reoiling, and the saving in lubricant is considerable.

The flexibility of the rollers also allows them to bear at all times their

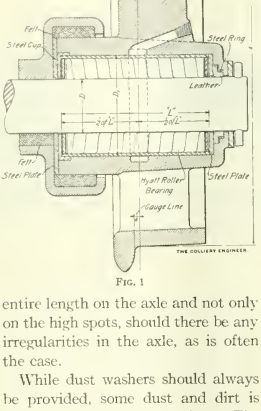


Fig. 1

entire length on the axle and not only on the high spots, should there be any irregularities in the axle, as is often the case.

While dust washers should always be provided, some dust and dirt is liable to work into the bearings. The spiral grooves of the Hyatt rollers will grind this up and it will be carried into the cores of the rollers where it will not harm the bearing surfaces.

The saving in power varies with conditions. In some cases it has run as high as 60 per cent., in others it has been as low as 30 per cent. A safe average is 40 per cent. to 50 per cent. Table 1 shows the results of tests made at the mine of Carbon Coal Co. on November 6, 1912. The cars used in the test had been in constant use for about 6 months, 25 cars being used in the test. The wheels were 16 inches in diameter with $2\frac{1}{4}$-inch axles and the Hyatt bearings were $2\frac{1}{4}$ in. × 5 in. The cars were all of the Kanawha Mine Car Co.'s type.

In adopting roller bearings for mine cars, it is essential that the proper size of bearing be used and that it be correctly housed. Of special importance is the distribution of load on the bearings. The center line of load must coincide with the center line of the bearing. The following tables showing sizes of bearings and locations in relation to load have been prepared by the Hyatt Roller Bearing Co.:

*Hyatt Roller Bearing Co., Chicago, Ill.

Wire Rope Haulage

*By Alfred Briggs**

When the entry in a coal mine gets too far away from the shaft for mule haulage to be profitable, the operator begins to look around for mechanical haulage. If the maximum grade

*Ottumwa Iron Works, Ottumwa, Iowa

Table 1

Type of Car	Average Start Pull Pounds	Average Constant Pull Pounds	Gross Weight Pounds	Up Grade Per Cent.	Constant Tractive Effort Per Ton Pounds	Tractive Effort Corrected for Level Pounds Per Ton
Kanawha Plain	297	120	5,800	.25	41.3	26.8
Kanawha Hyatt	104	80	5,800	.25	27.5	13.0

Table 2. Dimensions of Bearings in Inches For Significance of *A*, *D*, and *L*, See Fig. 1

Loaded Cars, Weighing 2½ Tons				Loaded Cars, Weighing 3½ Tons				Loaded Cars, Weighing 4½ Tons				Size of Bushings for Mine Car Wheels	
A	*D*	*L*	Service	*A*	*D*	*L*	Service	*A*	*D*	*L*	Service	*D*	D_1
12	2	5	Normal	12	2⅛	6	Normal	14	2⅜	7	Normal	1⅜	3⅞
14	2	6	Normal	14	2⅛	6	Normal	15	2⅜	7	Normal	1¼	3⅞
15	2	6	Normal	15	2¼	7	Normal	16	2½	7	Normal	2	4
16	2	7	Normal	16	2⅜	7	Normal	16	2⅜	8	Severe	2⅛	4⅛
18	2	7	Normal	18	2¼	8	Normal	18	2½	8	Normal	2¼	4⅛
18	2	8	Severe									2½	4½
												3	5¼

Maximum permissible bore = D_1 plus bore D_1 given in table.

against the load does not exceed 5 per cent. probably he will select a mine locomotive as the most serviceable machine.

There are, however, many mines where a locomotive, either electric, or gasoline, is not practical. Then it becomes necessary to choose wire-rope haulage. This consists of what is called the tail-rope and endless-rope system. The tail-rope system is the most flexible and may be adapted to almost any mine, as it requires only a single track and the ropes may be extended into cross-entries by a system of hooks and dead ropes. The standard endless-rope system requires a double track, and the ropes run continuously in one direction at a slow enough speed to permit of loaded cars being attached to the rope at any point and they are automatically released at the tipple.

A modified form of the endless-rope system is in use where the cars run on a single track at a much higher speed than the standard endless-rope system and the loads are carried from the terminal to the tipple and then the machine is reversed and the empties return to the point of starting. The Ottumwa Iron Works, of Ottumwa, Iowa, make a specialty of these several styles of wire-rope haulage, driven by either steam or electric power, and their engineers are prepared to furnish information regarding them and the conditions to which each is especially adapted, on request.

Rope-Haulage Systems

*By S. H. Pitkin**

Two of the representative rope-haulage engines built by the Wellman-Seaver-Morgan Co., of Cleveland, Ohio, are shown in Figs. 1 and 2. Fig. 1 is an illustration of the principal rope-haulage engine of the Cambria Steel Co., at their Rolling-mill mine at Johnstown, Pa.

This main and tail-rope haulage system is one of the largest in the country, and, so far as known, the only cross-compound Corliss condensing engine used for this kind of service. The engines have 28 in. ×48 in. high-pressure and 50 in. ×48 in. low-pressure cylinders with Corliss non-detaching valve gear, using steam at 100 pounds boiler pressure and exhausting into a central condenser connected with the power plant of the Cambria Works. The valves of these engines have automatic cut-off gears operated directly by the governor and requiring no attention on the part of the operator.

On the main engine shaft are mounted two winding drums 7 feet diameter by 60 inches face, built of steel plate with cast-steel heads and equipped with powerful band friction clutches and band brakes. The winding drums have a capacity for 10,000 feet of 1¼-inch wire rope. These engines handle a train of 85 to 100 cars, weighing 5,000 pounds each, loaded, which are hauled a maximum distance of approximately 9,000 feet on varying grades, the maximum being 3 per cent., the hauling speed being 900 feet per minute. The train of empty cars is returned to the mines by means of a tail-rope winding on the opposite drum traveling at the same speed.

This haulage system has been in operation for the past 9 years and furnishes the great Cambria plant with its entire supply of fuel.

Fig. 2 shows a recent installation of a large and modern electric driven haulage machine at the Keystone Coal and Coke Co.'s mines near Greensburg, Pa. This machine is designed to handle a load of 50 mine cars, weighing 170 tons, on a slope of varying grades, the maximum being 6½ per cent. and eventually 9,000 feet in length, there being a curve of 250 feet radius at one point in the entry on the steepest grade. The haulage drum is 8-feet diameter by 5-feet face, having steel-plate shell and heavy cast-steel heads with powerful band brake and clutch (both air operated), the brake being applied by weights and released by the air cylinders, as shown in the illustration. The hoist is connected to the motor by means of a pair of single-reduction steel gears having machined herring-bone teeth of ample proportions.

A 700-horsepower, General Electric, alternating-current motor furnishes the power for driving this hoist, running at a normal speed of 300 revolutions per minute. The motor is controlled by a liquid rheostat reversing controller.

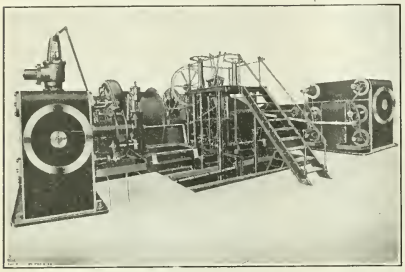


Fig. 1. Cross-Compound Corliss Haulage Engine

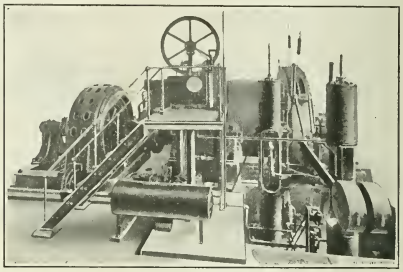


Fig. 2. Electric Haulage Machine

*First Vice-President The Wellman-Seaver-Morgan Co.

This hoist has a capacity for winding 9,000 feet of $1\frac{1}{4}$-inch rope at a speed of 1,000 feet per minute. The system of control employed enables the operator to start this heavy trip with ease and nicety, and the improved form of gear used renders the engine practically noiseless in its operation.

Signaling in Gassy Mines

In British mines the signaling apparatus must be so constructed and worked that there shall be no open sparking and consequently the system of carrying two bare wires side by side along the haulage roads whereby the signal is transmitted by connecting two wires by hand has to give way to some other method. It would be costly and inefficient to fix a series of gas-proof press buttons at intervals, and a good many systems have been devised in order to meet the conditions of the Home Office regulations. The arrangement known as the "Davis-Fryar," constructed by Messrs. John Davis & Sons (Derby) Ltd., appears to be a very practical and reliable system which is easily maintained in working order. The principle upon which this system is based is shown in Fig. 1. A contact maker, *B*, is placed in a suitable position and actuated by flexible wires which run along the side of the haulage road. These wires which are carried by small supporting pulleys *C* are anchored to the end remote from the contact maker *B*, pass over a pulley *D*, and are kept taut by means of weights *E*. Near pulley *D* one end of a short length of flexible wire is secured while the other end is attached to the contact maker. The electric contact is contained in a strong iron case *A* which is gas-proof, the actual contact being immersed in oil, while a removable cover enables it to be easily examined. The contact maker is double acting so that the flexible wire can be run right and left and in this way double the length of road can be served.

There is an installation of this description at the Denby colliery in Derbyshire, and it is believed that about 100 yards of road on either side of the box can be dealt with in this way. The signal is of course transmitted by pulling a flexible wire kept taut at any point by the weight *E* suspended from pulley *D*. The system is less costly than that of installing flame-proof push buttons. Moreover, the "Davis-Fryar" system is more efficient, owing to the fact that a signal can be transmitted from any part of the haulage plane, whereas push buttons are fixed only at intervals.

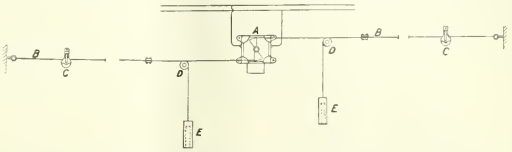


Fig. 1. Davis-Fryar Signaling Apparatus

Mine-Car Construction

*By W. D. Hockensmith**

Modern mine haulage demands mine cars and wheels of much higher class than the equipment in use twenty years ago.

Mine cars that were used for animal haulage, and later for rope haulage, were generally light in construction, as the service did not demand a heavier and stronger car, and it was and is desirable to keep the total weight of the car as low as possible. Naturally, when increased strength was required, the car had to be made heavier. The cars as now designed for motor-haulage work are almost universally equipped with center bumpers. This adds considerable strength to the bottom of the car.

The steel mine car, which is fast coming into use, has several advantages over the wooden car. One of these is that the steel car for the same capacity as the wooden car is somewhat lighter in weight. The steel car has also proved to be of satisfactory construction for mine use. A number of mines have had steel cars in use for ten years and the side plates are still in fair condition.

It has been proved that woodeen bottoms are much more satisfactory than steel bottoms, because the wood materially assists in taking care of the shocks. Mine cars constructed entirely of steel have spring drawbars, similar to railroad cars. These are expensive and add considerable weight to the car; besides the coupling arrangement is not so satisfactory as in the solid center bumper cars.

Another decided advantage in using wooden bottoms in steel cars, is that they can be used with wooden cars, so that a mine can begin replacement of wooden cars with cars made up of steel sides and ends and wood bottoms, without change in the coupling arrangements.

The old type of curved spoke chilled car wheel, once quite generally in use, has now proved unsatisfactory, owing to the constant shocks received, eventually breaking the spokes. With a straight spoke this trouble is eliminated.

The old type of square axle used on mine cars in the past is fast being replaced by the modern round axle of the floating type. With the use of the round axle uneven wear is eliminated and the lubrication of the car materially assisted. With round axles the boxings must be securely held in place on the car bottom. This has been taken care of, and the coal operator is able to purchase cars with axles that wear from three to four times longer than those of square construction.

Experiments during the last five years have proved that roller bearing wheels will not only materially

*V. P. & G. M. Hockensmith Wheel and Mine Car Co.

reduce the cost of haulage, but will also reduce the cost of lubrication to such an extent that a number of operators are considering the roller bearing wheel from this point alone. By the use of a roller bearing wheel, the mine tracks are practically free of the excess amount of oil that naturally wastes from the ordinary self-oiling wheel. The roller bearing wheel is lubricated with a non-fluid oil and is so arranged that this is contained in the hub.

The Fairmont Endless Cable Car Haul

The Fairmont endless cable car haul and retarder was first designed some 12 years ago to meet the demand of coal operators for the better handling of their coal and to allow the coal to be brought in the mine cars close to the point of loading into the railroad cars, and to do away with the necessity of elevators, conveyers, monitors, planes, and other systems which break the coal. It is an improvement on the old endless-rope haul which used hand grips or grip cars for pulling the cars.

The car haul consists of a wire cable passing around sheave wheels at the head- and foot-ends. The up-going rope carries the loaded cars and the descending one the empties.

In the retarder the up-going rope carries the empty car and the descending rope the loads. The sheaves are set in an approximately horizontal plane. One inch to 1¾-inch wire cable is used, depending on the requirements of service, with dogs clamped on at intervals which engage the bottom of the mine car.

The special features of the Fairmont system are the double finger dog and the compressing of the forward finger when receiving cars; the automatic spring take-up for keeping the cable in tension, and the safety switch used in connection with it, which stops the haul in case of accident; the noiseless ratchet and pawl; the well-braced covered guideway, and other minor points.

The builders are the Fairmont Mining Machinery Co., Fairmont, W. Va.

Producer-Gas Engines in a New Field

A fleet of large self-propelled barges, 15 in number, to ply between New Orleans and the coal fields of Northern Alabama, is of peculiar interest in that they are the first craft of their kind in America to be propelled by producer-gas engines. They are also the first to bring coal from the Alabama fields to New Orleans wharves by water. The Fairbanks-Morse Co., who furnished the equipment for this fleet, are justly proud of their achievement, and furnish the following data:

Starting from the coal fields the barges will proceed down the Black Warrior, Warrior, and Tombigbee rivers, across Mobile Bay, and then to New Orleans by way of Mississippi Sound, Lake Borgne, Lake Borgne canal, and the Mississippi River, a distance of about 500 miles.

The barges, which are of steel, have the following measurements: Length, 240 feet; width on deck, 32 feet; width at bottom, 28 feet; depth, sides, 8 feet; depth, center, 8½ feet. Each has a capacity of 1,000 tons; draft, when fully loaded, 7 feet. They are propelled by twin screws driven by twin engines and have a speed of approximately 7 miles an hour when fully loaded. The weight of barge and equipment is close to 240 tons.

The screws are driven at 300 revolutions per minute by two 75-horsepower vertical producer-gas engines. Gas for the engine is furnished by a 150-horsepower producer. The fuel used for the producer is a waste coke from the ovens of the Birmingham district. It has a calorific value of about 11,000 British thermal units and the consumption is approximately 1 pound per horsepower hour. Bunkers are provided to hold about 15 tons of fuel. Each producer is equipped with scrubber, gas tank, tar extractor, and is fitted with water bottom.

The auxiliary power equipment of the barge consists of a 9-horsepower gasoline engine, which drives a centrifugal pump handling the ballast and bilge water, a blower, an air compressor, and a 5½ kilowatt direct-current generator. Current is used for electric lights throughout the boat, fans in cabins and engine room, a 3,200-candlepower search light and a 5-horsepower motor. The arc light is mounted on the roof of pilot house and galley, which are immediately over the engine room. The motor is for operating an anchor winch. The generator is so mounted that when the large engines are running it may be belt driven from one of them. A second 4-inch centrifugal pump is also installed to be driven by one of the large engines through friction-wheel contact.

A decided advantage of the self-propelled barge for use in these waters is that they can negotiate the numerous locks on the Warriors and Tombigbee rivers in much less time than if towed. Each lock can be passed in 20 minutes by these vessels, whereas more than an hour would be consumed by the towed-fleet system.

The barges will make the trip from the mine region to New Orleans in 72 hours, and with all 15 vessels in service it is estimated that coal will be moved into New Orleans at the rate of 50,000 tons a month. Added revenue will be derived by the barges carrying freight on the return trip to the coal field.

The Alabama & New Orleans Transportation Co., of which John H. Bernhard is vice-president and general manager, controls the Lake Borgne canal, which is the key to the route traversed by these barges, and it is to them that the new departure in Alabama coal transporation is due. All the barges are being built at the company's own ship yard, located at a point about 12 miles below New Orleans, where the canal empties into the Mississippi. The first barge was launched June 4, and it, together with one launched in July, is now in commission. A third boat has been launched—it being the company's plan to construct one a month until the fleet numbers 15 vessels.

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

39. A high-tension cable is to be placed in a shaft 800 feet deep. How would you hang the cable and support it in the shaft, assuming it could not be made self-supporting? Illustrate by sketches.

40. Show by sketches which, in your opinion, is the most reliable method for holding cars in cages. Mention various appliances in use, pointing out the advantages and disadvantages of each.

41. A pump whose water end is 10-inches in diameter has to work 19 hours a day. What size pump will have to be provided to replace this to do the same work in 8 hours, with twice the steam pressure, the length of stroke, etc., remaining the same?

42. A ventilating fan is driven by an electric motor. It is proposed to install an auxiliary motor of the same power. Show by sketches how you could connect the motors so that a change could be made from one motor to the other without stopping the fan.

Answers for Which Prizes Have Been Awarded

Ques. 27.—In boring a hole through a coal barrier 140 feet wide in a 5-foot seam, what is the greatest difficulty you would expect to meet, and how would you overcome it, the head of water being 120 feet?

Ans.—It seems to me that the greatest difficulty that is liable to be encountered in this operation would be that of tapping the water so as to prevent any injury to those engaged in the work by the velocity with which the water would issue from the bore hole. I will assume that the hole is drilled with a diamond drill of 2-inch bore. The pressure per square inch under a head of 120 feet would be slightly more than 52 pounds. This pressure upon a hole 2 inches in diameter and 140 feet long would produce a velocity of about 64 feet per second at the discharge end. The total pressure tending to shatter the coal immediately in front of the hole would be that exerted upon an area equal to the area of the hole, or, $2^2 \times .7854 \times 52 = 164.36$ pounds.

A thickness of coal of 1 foot between the end of the bore hole and the water would be more than sufficient to withstand this pressure. Having drilled the hole a distance of 139 feet; I would insert a charge of quick-acting explosive in the hole to shatter the remaining foot of barrier; have every one withdraw from the vicinity of the hole, and explode the charge by means of an electric battery.

I. C. Parfitt

Jerome, Pa.

Second prize, W. H. Luxton, Linton, Ind.

Ques. 28.—An entry 3,600 feet long falls 350 feet 6 inches. (*a*) What is the gradient of the road? (*b*) What kind of haulage would you install on such a road to get up 800 tons a day? Give reasons for and describe the salient points of the installation.

Ans.—Assuming a single-track haulage, and that the grade is referred to the pitch distance instead of the horizontal, as is the custom of some engineers in steep pitches. The sine of the angle of inclination must be used in place of the tangent, (*a*) hence $(350.5 \div 3{,}600) \times 100 = 9.736$ per cent.

According to the explanation below, it is feasible in this case to install an engine-plane haulage, using either a steam or electric hoist of a rated horsepower shown by the following solution:

To get up 800 tons over this road, it would be well to design the empty mine cars to weigh 1,600 pounds, and having a capacity of 4,000 pounds, consequently it is necessary to hoist 400 cars daily.

On an engine-plane haulage, it requires about as long to drop an empty trip down the plane as to hoist a loaded trip, so only one-half of the actual working hours of each day are consumed in hoisting loaded trips. Furthermore, suppose 30 minutes lost each day, changing the rope from the loaded trip to the empty trip, and assuming the mine to work

10 hours each day, the actual hoisting time equals one-half of 10 hours or 5 hours, minus ½ hour = 4½ hours equals hoisting time.

Suppose the engine speed equals 6 miles per hour, in 4½ hours the distance covered equals $6 \times 5{,}280 \times 4\frac{1}{2} = 142{,}560$ feet. The plane is 3,600 feet long, so it is necessary to make $142{,}560 \div 3{,}600 =$ say 40 trips daily; and each day the mine must produce 400 mine cars of coal or $400 \div 40 = 10$ car trips. $(1{,}600 + 4{,}000) \times 10 = 56{,}000$ pounds = weight of loaded trip. $56{,}000 \times .09736 = 5{,}452.16$ pounds traction due to gravity. $56{,}000 \times \frac{1}{40} = 1{,}400$ pounds traction due to friction. $5{,}452.16 + 1{,}400 = 6{,}852.16$ pounds = total tractive force of loaded trip $= \frac{6{,}852.16}{2{,}000} = 3.43$ tons.

The breaking load of a 1-inch, 6-strand, 19-wire, extra strong, cast-steel rope is 39 tons. In ordinary mining practice it is customary to use a factor of safety of 10; hence, 1 inch is strong enough for the work on hand.

The empty trip on a down grade or dip of 9.736 per cent. would have a gravity force of $1{,}600 \times 10 \times .09736 = 1{,}567.76$ pounds, and would have a resistance due to friction of $1{,}600 \times 10 \times \frac{1}{40} = 400$ pounds.

As a force of 1,567.76 pounds will overcome an opposing force of 400 pounds, the trip will run in by gravity, so it is evident that an engine plane will work satisfactorily.

A 1-inch rope weighs 1.58 pounds per linear foot. $3{,}600 \times 1.58 = 5{,}688$ pounds, weight of rope.

Traction due to gravity of this rope equals $5{,}688 \times .09736 = 553.78$ pounds.

Traction due friction $= 5{,}688 \times \frac{1}{40} = 142.2$ pounds. The total tractive force on the engine equals $5{,}452.16 + 1{,}400 + 553.78 + 142.2 = 7{,}548.14$ pounds.

As there are 40 trips to be hauled, at a speed of 6 miles per hour, each trip travels a distance of 3,600 feet. Assuming one-half hour lost changing rope from loaded trip to empty trip, and one-half of the time of each day or one-half of 10 hours = 5 hours lost dropping empty trips down the slope or 5 hours minus ½ hour = 4½ hours actual hauling or hoisting loaded trips, the time consumed hoisting each trip = $\frac{1}{40}$ of 4½ hours or 270 minutes = 6.75 minutes, or in 1 minute the trip travels $3{,}600 \div 6.75 = 533.33$ feet = velocity,

$$\frac{7{,}548.14 \times 533.33}{33{,}000} = 121.99 \text{ horsepower}$$

If this mine gets the power from a substation, it would be practical to install an electric hoist, well designed and using a 4-foot drum with sufficient flange to hold the entire rope plus 4 inches; but where a steam plant is already installed, it is practical to install a steam hoist, well designed of the compound type. As the rollers on the haulage road, greatly reduce the friction of the rope, and also prolong the life of the rope, it is well to have a sufficient amount of power installed.

Special provisions must be made on the outside for a proper landing as well as inside for the landing of empty trips.

Philip M. Weigle

Hooversville, Pa.

Second prize, Edwin Oakley, Hiteman, Iowa.

Ques. 33.—Does the reading of a water gauge at the foot of an air-shaft differ from one taken at the fan on the surface? If so, which is the greatest? Illustrate by a practical example?

Ans.—Owing to the power consumed in the shaft the pressure would not be the same. The question as to where the greatest pressure will be, depends on the kind of a fan used. If a blower fan is used the pressure will be the greatest at the fan. Or, if an exhaust fan is used, the pressure will be the greatest at the foot of the air-shaft. Because air-currents like liquids always move from a point of greater pressure toward a point of lesser pressure. But, unless the power is increased, the speed at which the air travels gets less as the airways get longer. Or, as the rubbing surface increases the velocity decreases for the same power applied. To illustrate this, assume a mine ventilated by an exhaust fan. The size of the airway is 5 ft. × 10 ft. and 3,000 feet long. Then the rubbing surface of the airway is $[2(5+10) \times 3{,}000] = 90{,}000$ square feet.

Assuming the velocity of the air at the foot of the shaft to be 500 feet per minute, then for pressure $P = \frac{R}{a}$

$$= \frac{K S V^2}{a} = \frac{.00000002 \times 90{,}000 \times 500^2}{50}$$

$= 9$ pounds per square foot.

Now, assume the air-shaft to be 5 ft. × 10 ft. and 600 feet deep. Then the rubbing surface of the shaft is 18,000 square feet.

The rubbing surface of the airway and shaft combined is $90{,}000 + 18{,}000 = 108{,}000$ square feet. Then,

$$V_2 = \sqrt{\frac{K S_1 V_1^2}{K S_2}} = \sqrt{\frac{450}{\frac{K S_2}{.00216}}} = \sqrt{208{,}333} = 456 \text{ feet per minute.}$$

Then as before,

$$P_2 = \frac{K S V^2}{a}$$

$$= \frac{.00000002 \times 108{,}000 \times 456^2}{50} = \frac{449}{50} =$$

8.98 pounds per square foot.

This shows that increasing the rubbing surface decreases the pressure, when the power remains constant, or the velocity varies inversely as the cube of the rubbing surface.

Wm. Bailey

Colliers, W. Va.

Second prize, W. J. Mazy, Corbin, B. C., Canada.

Ques. 34.—A self-acting jig plane has an inclination of 25 degrees and a length of 500 feet. A loaded car weighs 3,500 pounds; an empty car weighs 1,500 pounds; balance weight 4,800 pounds; and the rope 1.6 pounds per linear foot. How many cars are used per trip, assuming the coefficient of friction to be one-thirtieth?

Ans.—In the formulas where letters have been used, N = number of cars; W_1 = weight of loaded car; W_e = weight of empty car; W_t = weight of balance truck; W_r = weight of rope; f = coefficient of friction.

Assume the number of loaded cars to make this jig plane self-acting to be two; then when the loaded cars are at the top of the plane and the balance truck is at the bottom, the

resistance due to the weight and friction of the rope is found by the formula,

$$P_1 = (30 \sin 25° + \cos 25°) \frac{W_r}{30}$$

$$P_1 = (30 \times .42262 + .90631) \frac{500 \times 1.6}{30}$$

$$= 362.26 \text{ pounds}$$

The frictional resistance of the cars and balance truck is found by the formula

$$P_2 = f\,(N\,W_1 + W_t)\cos 25°$$

Then assuming two cars are used,

$$P_2 = \tfrac{3}{10}(2 \times 3{,}500 + 4{,}800)\ .90631$$

$$= 356.48 \text{ pounds}$$

The total resistance is then 362.26 +356.48 = 718.74 pounds.

The gravity pull that tends to produce motion is found by the formula,

$$P = (N\,W_1 - W_t)\sin 25°$$

$$P = (2 \times 3{,}500 - 4{,}800)\ .42262$$

$$= 927.76 \text{ pounds}$$

The gravity pull of the loaded cars exceeds the resistance by 929.76 −718.74 = 211.02 pounds.

Now solve with the balance truck at the top of the plane and the empty cars at the bottom. The resistance due to the weight and friction of the rope is the same as before. P_1 = 362.26 pounds. The frictional resistance of the cars and balance truck is found by the formula,

$$P = f\,(W_t + N\,W_e)\cos 25°$$

$$P_2 = \tfrac{3}{10}\,(4{,}800 + 2 \times 1{,}500)\ .90631$$

$$= 235.64 \text{ pounds}$$

The total resistance is then 235.64 +362.26 = 597.90 pounds.

The gravity pull that tends to produce motion is found by the formula,

$$P = (W_t - N\,W_e)\sin 25°$$

Substituting,

$$P = (4{,}800 - 2 \times 1{,}500)\ .42262$$

$$= 760.72 \text{ pounds}$$

The gravity pull of the balance truck exceeds that of the empty cars and rope by 760.72 − 597.90 = 162.82 pounds. Hence, two cars make the proper number per trip.

C. T. Griswold

331 Fourth Ave., Pittsburg, Pa.

Second prize, W. E. Hobson, Jenkins, Ky.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not neccessarily for publication.

The editors are not responsible for views expressed by correspondents.

Compound Interest by Logarithms

Editor The Colliery Engineer:

Sir:—Dr. A. Taylor, of Central Butte, Colo., has recently figured out a system by which the compound interest on $1 for any number of years at any rate can be found at one operation.

Example.—Find the compound interest on $1 for 9 years, the rate being 7 per cent.

Solution.—Add the rate to the principal and raise it to the ninth power by logarithms, thus

$$(1.07)^9 = 1.839. \quad \text{Ans.}$$

Example.—Compound the interest on $1 for 16 years at 5 per cent.?

$$(1.05)^{16} = 2.1829. \quad \text{Ans.}$$

J. Q. McNatt

Florence, Colo.

A Defense of the Carbide Lamp

Editor The Colliery Engineer:

Sir:—I have just read with a peculiar mixture of amusement and sense of outraged justice Mr. Shoemaker's indictment of the carbide lamp (September Colliery Engineer).

Frankly, I do not think well of Mr. Shoemaker's argument. I can readily appreciate, however, that an experience such as he relates as a personal one—that of being lost in the fathomless recesses of a deep, dark coal mine with only two matches and a carbide lamp, with the use of which his letter reveals his lamentable unfamiliarity—is not calculated to produce a frame of mind receptive of a presentation of its virtues.

However, I had an experience equally disconcerting, differing somewhat in the fact that I was not equally disconcerted—that is, not permanently so.

The first time I used a carbide lamp an unkind fate—and an exacting employer—made it necessary for me to stand for some minutes waist-deep in a hole of water. At about the moment I was ready to emerge my perfectly new and, till the moment, perfectly good lamp, decided to "hide its golden light." I struck several matches but it refused to ignite. I emptied the charge of carbide, which I had put in about 5 minutes previously, into the water and struck another match. Then—gentle reader—it happened.

My cosmopolitan colleagues took me to the outside and bathed my face and hands with sweet oil and invoked the blessings of whatever gods they prayed to in my behalf, and eventually, minus my most highly prized tresses and plus a somewhat more developed sense of caution, I returned to the mine—and with a carbide lamp.

Since then I have used one continuously. They give more illumination, are more economical, more cleanly, and do not require recharging as often as does an oil lamp. Had Mr. Shoemaker resorted to the simple expedient of sucking the tube of his lamp when it became obstructed the chances are he could have saved himself his unpleasant experience. Not a pleasant thing to do I grant you, but I wonder if he ever found it necessary to draw up the hot wicking of a lard-oil lamp with his teeth?

In the field in which I am located I think it safely within the bounds of conservatism to say that 70 per cent. of the underground employes use the carbide lamp, nor could they be easily

induced to discard it for another kind, more especially for the oil lamp, which in this field is rapidly becoming obsolete.

Frequently the manufacturers leave the cavity in the tubes too small and it is necessary to redrill them. This can be accomplished by means of a small wire, preferably a banjo string.

I believe that if Mr. Shoemaker would give the carbide lamp a reasonable try-out he could not find it in his heart to condemn it. E. B.

Acetylene Lamps

Editor The Colliery Engineer:

Sir:—A number of us in this section of the country have read the opinions expressed in The Colliery Engineer on the use of acetylene lamps in coal mines, and I wish to state my experience with them.

When first coming to this country I thought the oil lamp superior to the Marsaut safety lamp. After changing to the Baldwin acetylene lamp I felt at first that I should have to throw it away for, like a stylographic pen, it was always useless when most needed, but now I could not be induced to return to the use of oil lamps under any consideration whatever.

An objection has been raised to carbide lamps, that owing to their need of fresh carbide and water from time to time, the day laborers would get together and thus lose time. Let me state that they meet in groups with oil lamps as well, to borrow cotton, oil, etc. They get together when using safety lamps, and to my mind will continue to do so in the future regardless of the circumstances.

As far as a man's religion is concerned, which might be ruffled by the eccentric operation of a lamp, I think that if mine bosses have any religion they don't carry it into the mine with them, so none is lost due to the carbide lamp going wrong any more than any other lamp.

The advantages of the carbide lamp are in my estimation:

1. The most economical lamp.
2. The best light, a most important item.
3. Eye straining not as great as with other lamps, a decided advantage to engineers and officials.

As to overcoming the difficulties arising from the use of the carbide lamp I will say that when I had but one lamp I carried spare parts with me; but now having two lamps, I carry the old one with me, kept in such shape that it will last the day should anything go wrong with my other lamp, yet seldom have I been compelled to use it.

The carbide lamp is almost automatic in its action and I believe its success depends on this principle. I believe that the greatest difficulties in their use arise from improper handling. W. H. Luxton

Linton, Ind.

The Oklahoma Undercutting Law Repealed

Editor The Colliery Engineer:

Sir:—At the last session of the Oklahoma legislature a bill was passed requiring all coal to be undercut. The bill was passed with a strong vote from each house of the legislature. When the bill reached the governor a strong protest was made by the officers of the United Mine Workers against the signing of the bill, but after careful consideration of the measure from all sides the governor signed the document. The law would become effective July, 1914. The representatives of the miners' union at once got busy and asked for a referendum vote on the question at a special election. They secured the required number of signatures to the petition, from the miners and citizens of the mining region and labor unionists over the state. The date set for the election was August 5, at which time four other special state questions were voted upon. The law was defeated in the election. The percentage of the total vote of the state cast at this election was very low, but out of the vote cast the question received 73,345 votes for the repeal of the law and 21,559 against the repeal.

In Oklahoma the mine-run law and the practice of shooting from the solid are in force absolutely unrestricted. The result being that the coal mined produces from 25 to 60 per cent. slack and small sizes. Forty to 60 per cent. of the coal is lost forever by the present system of mining. Coal prices are high and the coal reaches the consumer in a very bad condition. Many accidents have occurred in the mines and in general conditions are bad. The Oklahoma coal has met sharp competition from the Colorado, New Mexico, and Alabama fields.

The legislature appointed a special committee to investigate the conditions in the field. The committee sitting as a court received much information from the testimony of miners, mine operators, state mine inspector and deputies, the State Geological Survey, and practical mining men. Members of the committee also investigated conditions first hand in the field.

As a result of this investigation the law was passed requiring the coal to be mined or undercut—that is by the law shooting off the solid was prohibited and the coal to be one-half mined for the full length of the hole made in the preparation of the shot before any shot was fired.

In 1912, 86.4 per cent. of the coal mined in Oklahoma was shot off the solid, and about 7 per cent. was mined by machines. Lump coal sells over the state at $8 to $10 per ton. The average price of coal at the mine is $2.14, almost double the average for the United States.

C. W. Shannon

Norman, Okla.

Underground Rubbish Car

Editor The Colliery Engineer:

Sir:—In answer to G. E. Lyman's request for a dump car to handle rubbish underground I enclose a sketch and description of one I have used many years.

From Fig. 1 it may be seen that it consists of a car with doors at both ends so that in unloading men can shovel from both ends. The car, when empty and standing in narrow places underground with the doors open, affords a passageway for mules, as they are easily taught to walk through the car.

A good size for this car is 4 feet long by 2.5 feet high by 2 feet wide inside, where grades up to 6 or 8 per cent. are to be negotiated by mule haulage; with less grades of course the car can be made larger. The construction is as follows: The bottom is of 2-inch plank with car boxes attached by bolts whose heads are countersunk to make a smooth surface for shoveling. The sides and doors are made of $1\frac{1}{2}$-inch plank and held in position by car irons constructed for the purpose. The drawbar is placed below the car irons so that the bolt holes in the wood floor, the car irons, and drawbar, will be in alinement for the necessary bolts to rigidly fasten them together. All bolt heads are countersunk inside the car. The strap hinges *a* used on the doors are looped for the pin *b*, which is of 1-inch round iron.

In order to hold the door shut, there is a flat iron *c* fastened to the car as shown, and a loop *d* which passes over it and is held in position by the pin *e* fastened by a chain to the car to prevent it becoming lost.

William John Mazey,
Inspector
Corbin, near Fernie, B. C.

What is Dynamite Anyhow?

Editor The Colliery Engineer:

Sir:—The United States Bureau of Mines recently sent out a pamphlet on the analysis of black powder and dynamite. The bulletin is published for the information of all persons interested in explosives and their safe and efficient use in mining work. The reader is informed that the term "ordinary dynamite," though much used, has no conventional meaning. Then, an example of "ordinary" dynamite is given as follows:

	Per Cent.
Nitroglycerine	40
Sodium nitrate	44
Wood pulp	15
Calcium carbonate	1

Ordinary 40-per-cent. dynamite does not mean the explosive contains 40-per-cent. nitroglycerine, but that it has an equivalent strength of 40-per-cent. nitroglycerine.

I have ordered many cars of dynamite but always specified 40-per-cent. or 60-per-cent. nitroglycerine. This mixing of names will probably cause some to order stronger explosives than they want, for the bulletin states "ordinary dynamite consists essentially of nitroglycerine absorbed in some porous material." The composition of ordinary dynamite given by the United States Bureau of Mines as a standard contains an active base

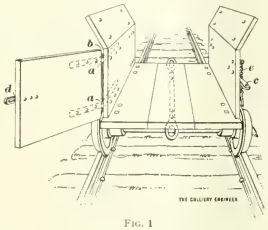


Fig. 1

which must materially increase its strength, at any rate it is going to seriously mix up matters between the consumers and manufacturers.

Will you kindly advise in regard to this matter. Reader

The editor referred the above to F. H. Gunsolus, the technical manager of the DuPont Co. His reply follows:

"In the last year or two there has been a tendency to drop the word 'nitroglycerine' in speaking of any kind of explosives. One reason is that there are so many different kinds of explosives now manufactured which are of the same strength and yet do not in any way contain the same per cent. of nitroglycerine. However, they do contain other explosive ingredients which bring them up to the strength designated.

"In other words, when dynamite was first manufactured the only explosive ingredient known was nitroglycerine. At that time they adopted the terms '40-per-cent. nitroglycerine,' '60-per-cent. nitroglycerine,' etc., and this meant that there was 40 per cent. of nitroglycerine or 60 per cent. of nitroglycerine in those particular explosives. Later on gelatine dynamite was discovered and manufactured. With the gelatine dynamite a 40-per-cent. gelatine does not contain 40 per cent. nitroglycerine, but it does contain a large percentage of nitroglycerine, a percentage of nitro cotton, and is so manufactured that a 40-per-cent. gelatine is equal in strength to a 40-per-cent. nitroglycerine. The same applies to explosives known as 'extra,' or the ammonia explosives.

"Believing that there would be considerable confusion in still maintaining the old terms 40-per-cent. nitroglycerine and 60-per-cent. nitroglycerine, and also due to the fact that the gelatine or 'extra,' or many other explosives, did not contain the same per cent. of nitroglycerine that the straight nitroglycerine explosives contained, it was deemed better to use the terms 40-per-cent. strength, 60-per-cent. strength, etc.

"Within the past year the duPont Powder Co. has adopted the word 'Straight' to represent the nitroglycerine explosives, the word 'gelatine' to represent gelatine explosives, the word 'Extra' to represent the extra or ammonia explosives. By doing this and adopting the term per cent. strength, we find there is very little, if any, confusion among our customers. However, we will say that occasionally, but it is a rare exception, some customer feels that a 40-per-cent. strength gelatine or a 40-per-cent. strength extra explosive should contain 40 per cent. of nitroglycerine. However, after this is carefully explained to customers we find that they readily agree with the designations used and are in hearty accord with same." F. H. Gunsolus

Coal Saved by By-Product Ovens

Probably the average yield from coal coked in beehive ovens is $62\frac{1}{2}$ per cent. of the coal, while 75 per cent. would be the average yield from by-product ovens. In 1912, 65,485,801 tons of coal were used for coking purposes, from which 11,048,489 tons of by-product and 32,868,345 tons of beehive coke was made. It would appear from these figures that 4,110,543 tons of coal could have been saved had the same amount of coke been made in by-product ovens.

Practical Talks on Coal Mining

For men who desire information on Coal Mining and related subjects presented in a simple manner

Electricity in Mines

Relation Between Electromotive Force, Resistance, and Current—The Drop or Fall of Potential

By H. S. Webb, M. S. *(Continued from September)*

SINCE the current is forced through a circuit by an electromotive force applied to the circuit, the greater the electromotive force, the greater will be the current, other conditions remaining the same; in other words, the current strength in any electric circuit is directly proportional to the electromotive force of the circuit. A change in the electromotive force causes a like change in the current.

All circuits have resistance; a circuit of no resistance whatever, if it were possible to obtain such, would allow the smallest imaginable electromotive force to set up a very large current. The resistance of one portion of a circuit may be low, while at another portion it may be high. For example, if a heavy copper bar is laid across the terminals of the battery, as indicated by *a b* in Fig. 16, a large flow of current might be expected, because the copper bar has such a low resistance. But the resistance of the battery itself may be high; in which case the current will not be large because the total resistance of the circuit is large, although the external resistance represented by the bar *a b* is small.

The form in which Ohm's law has been given is used in problems where the electromotive force and resistance are known and the current must be calculated. Ohm's law may also be written in the two following forms:

Electromotive force in volts = current in amperes × resistance in ohms; or volts = amperes × ohms. (1)

$$\text{Resistance in ohms} = \frac{\text{electromotive force in volts}}{\text{current in amperes}} \quad (2)$$

$$\text{or ohms} = \frac{\text{volts}}{\text{amperes}}.$$

To find the electromotive force necessary to force a known current through a known resistance, use formula 1.

Fig. 16

Example 1.—The total resistance of a circuit is 2 ohms; what electromotive force must be applied to produce a current of 15 amperes?

Solution.—Applying formula 1, the electromotive force in volts equals the current in amperes multiplied by the resistance in ohms, or, the electromotive force = 15 × 2 = 30 volts. Ans.

To find the resistance of a circuit when the electromotive force and current are known, use formula 2.

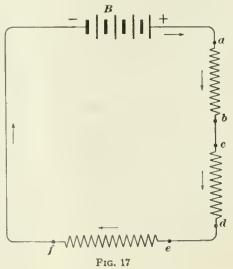


Fig. 17

Example 2.—An electromotive force of 1.8 volts applied to a circuit produces a current of .6 ampere in the circuit; what is the resistance of the circuit?

Solution.—Applying formula 2, the resistance in ohms

$$= \frac{\text{electromotive force in volts}}{\text{current in amperes}}$$

$$= \frac{1.8}{.6} = 3 \text{ ohms. Ans.}$$

Drop or Loss of Potential

The amount of water that will flow through a pipe in a given time depends on the pressure of the water and the resistance of the pipe. In a similar manner the quantity of electricity that will flow through a conductor depends on the pressure, or electromotive force, acting through the conductor and the resistance of the conductor. Suppose that a voltaic battery sends a current through a series of conductors arranged as in Fig. 17, where *B* is the battery, *a b* a resistance of a certain value, *c d* a resistance of another value, and *e f* a resistance of still another value. These resistances, together with that of the battery, are all in series, constituting a simple series circuit. The strength of the current is the same in all parts of the circuit and its actual value is obtained by dividing the electromotive force developed in the battery by the sum of all the resistances, including the internal resistance of the battery. Part of the total electromotive force is required to force the current through each resistance and the greater the

resistance of any part of the circuit, the greater will be the electromotive force required to send the same current through it. The electromotive force required to send a current through a resistance is called the drop, or fall, of potential through that resistance. When a break occurs anywhere in the circuit the resistance of the air at the break is so great that no current can pass through the circuit and the entire electromotive force of the battery is applied between the two terminals across the break. As no current is flowing, when the circuit is thus opened, there is no loss of potential in the wires.

As a rule when considering a circuit in which a current flows it is the external circuit that demands attention, and instead of using the total electromotive force developed in the battery, the difference of potential existing across the terminal of the battery B is used. Considering any portion of the external circuit, the relation existing between the resistance of that portion, the potential across it, and the current flow, is exactly the same as the relation existing between the total resistance of the circuit, its total electromotive force, and the current. The electromotive force through a conductor is usually called the drop, or loss, of potential through the conductor. To calculate the drop of potential in volts across any conductor of a circuit, multiply the current in amperes flowing through the conductor by its resistance in ohms.

Example 1.—In Fig. 18 the resistance of the conductor $a\,b$ is 2.4 ohms and the current flowing through this conductor is .833 ampere; what is the drop in volts, between the terminals a and b of the conductor?

Solution.—The drop in volts equals the current in amperes multiplied by the resistance in ohms; that is, $.833 \times 2.4 = 2$ volts, nearly. That is, the drop of potential from a to b is 2 volts, or the difference of potential between the terminals a and b is 2 volts. Ans.

Example 2.—Fig. 19 represents a circuit in which a current of 3 amperes flows; the resistance from a to b is 1.5 ohms; from b to c 2.3 ohms; and from c to d 3.6 ohms; find the difference of potential or drop between a and b, between b and c, between c and d, and between a and d.

Solution.—The difference of potential, or drop, between a and b is

Fig. 18

3 amperes $\times$ 1.5 ohms = 4.5 volts; between b and c is $3 \times 2.3 = 6.9$ volts; between c and d is $3 \times 3.6 = 10.8$ volts; between a and d is $4.5 + 6.9 + 10.8 = 22.2$ volts, or, in other words, the loss, or drop, of potential caused by a current of 3 amperes flowing between a and d is 22.2 volts.

The drop between a and d could also be obtained as follows: The total resistance between a and d is $1.5 + 2.3 + 3.6 = 7.4$ ohms. The current is 3 amperes; hence, the drop between a and d = 3 amperes $\times$ 7.4 ohms = 22.2 volts. Ans.

To find the resistance in ohms when the drop of potential across any conductor and the current flowing through it are known, use the following rule:

Rule.—The resistance in ohms is equal to the drop in volts across the conductor divided by the current in amperes flowing through the conductor. This may be expressed by the formula,

$$\text{resistance in ohms} = \frac{\text{drop in volts}}{\text{current in amperes}}$$

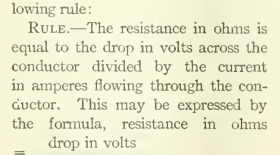


Fig. 19

Example.—The current flowing through a certain conductor is 2 amperes, the drop across the conductor is 10 volts, what is its resistance?

Solution.—Resistance

$$= \frac{\text{drop in volts}}{\text{current in amperes}} = \frac{10}{2} = 5 \text{ ohms.} \quad \text{Ans.}$$

In many cases, it is desirable to have the current flow from a generating station or dynamo to some electrical device, such as a motor or a group of lamps situated at considerable distances from the station or dynamo, and return without causing an excessive drop of potential in the conductor leading to and from the two places. Under these conditions, it is customary to decide on a certain drop of potential beforehand, and from that and the current, calculate what the resistance of the two conductors may be in order to limit the drop to the allowable amount.

Example.—It is desired to transmit a current of 5 amperes to a group of lamps situated 500 feet from the source. The total electromotive force applied to the terminals of the circuit is 120 volts, and only one-tenth of this potential difference is to be lost in the conductors leading to and from the lamps. (*a*) Find the resistance of the two conductors. (*b*) Find the resistance per foot of the conductors, assuming each to be 500 feet long.

Solution.—(*a*) The total allowable drop of potential in this case is one-tenth of 120 or 12 volts; therefore, since the drop is 12 volts and the current is 5 amperes, the total allowable resistance of the two conductors (outgoing and returning) in series is equal to $\frac{\text{drop in volts}}{\text{current in amperes}} = \frac{12}{5} = 2.4$ ohms. The resistance of each wire, since there are two, must, therefore, be limited to $\frac{2.4}{2} = 1.2$ ohms. (*b*) Since the two conductors in series are 1,000 feet long and have a resistance of 2.4 ohms, the resistance per foot must be $\frac{1}{1{,}000}$ of 2.4 ohms, or $2.4 \div 1{,}000 = .0024$ ohm. Ans.

The current in amperes that a given electromotive force will send through a given resistance is equal to the difference of potential, or drop, across the conductor in volts divided by the resistance in ohms.

Example.—The drop across a 16-candlepower incandescent carbon

filament lamp burning at normal brightness is 110 volts, its resistance while hot is 220 ohms, what current does it take?

SOLUTION.—The current in amperes $= \frac{\text{electromotive force in volts}}{\text{resistance in ohms}}$

$= \frac{110}{220} = .5$ ampere. Ans.

(To be Continued)

Mechanics of Mining

An Explanation of the Principles Underlying Calculations Relating to Engines, Pumps, and Other Machinery

By R. T. Strohm, M.E. *(Continued from September)*

FRICTION.—There are many examples of sliding friction to be found in mining machinery. For example, there is sliding friction between the cage and its guides; between the piston and the cylinder of the engine or pump; between the shaft and the bearing in which it turns; and between the piston rod of an engine and the stuffingbox in which it moves.

In all of these cases, lubricants are used to reduce the friction, so that there shall be as little lost work as possible. If the guides for the cage are dry, a greater force must be used to hoist the cage in the shaft; if the piston in the cylinder is not lubricated properly, it will move less easily and a large part of the work done by the steam will be used to move the piston, whereas it should be used to lift the load; and if the bearing runs dry, the shaft will turn much harder and power will be wasted. The use of lubricants enables these surfaces to slide smoothly and with less resistance.

But there are other disadvantages of friction, namely, wear and heating. When the ridges of one surface are bent or broken by those of the other surface, wear results. When two pieces slide together for some time, they will become smooth and shiny, even though they are well lubricated. This is because the ridges on the surfaces are torn off or bent down, so that they are not so high as before, and the surface is therefore less rough.

If two surfaces are allowed to rub together very long without any lubrication, they will get hot. An example of this is a hot box on a car axle. The box runs dry or some grit works its way into the bearing, and the friction increases to such an extent that the metal warps and cracks. The lubricant serves not only to reduce the friction, but it also carries away the heat that is made by the rubbing.

Usually, friction is looked on as something undesirable; but there are

FIG. 36

case, in which it is very useful For example, the brake band on a hoisting drum sets up a great deal of friction when it is tightened, and so brings the drum to a stop. In this case friction is desirable, because the brake would be worthless if it did not cause friction.

Again, friction is desirable in the case of a friction clutch that is used to connect two shafts so that one shall drive the other. Here it is the friction between the two parts of the clutch that makes them grip and turn as one piece. If there were no friction, one part would slide on the other and the clutch would be of no value.

There is another kind of friction, known as "rolling" friction, which is the resistance that one body offers to another that rolls on it. The wheels of a mine car in running along a track set up rolling friction, and that is why it requires a considerable pull to move the car, even on a level track. This friction is due to dirt on the rails and the wheels, and to unevenness.

LAW OF MOTION

The first law of motion, as expressed in a foregoing article of this series, stated that a moving body would keep on moving in a straight line unless it was acted on by some external force that would change its motion. If a body is compelled to move along a curved line by some external force, it will still have a tendency to keep on moving in a straight line. This tendency may be seen in a number of familiar instances.

For example, take the case of a mine car running along a track that has a curve in it, as shown in Fig. 36. The car *a* is supposed to be in motion in toward the right. Along the straight part of the track the car runs smoothly, with no particular tendency to run to either side. But as soon as the front wheels strike the beginning of the curve, at the position *b c*, the car pushes or crowds outwards against the outer rail *d*. In going around the curve, the same tendency is shown; that is, the car presses outwards against the outer rail as though it were trying to move farther away from the center *e* of the curved part of the track.

This tendency is due to the fact that the car tries to keep on moving in a straight line. If it were free to do so, it would go ahead in the direction of the straight dotted track at *f* and *g*. But the track is of such shape as to force the car to move in a circular path.

The flanges on the outside wheels *h* press outwards against the rail *d* when the car strikes the curve and tends to follow a straight line. If the speed and weight of the car are very great and the wheels strong enough, the rail may be broken or torn loose from the track, showing that there is a large force exerted toward the outer side of the curve, away from the center. Ordinarily, however, the rails and the wheels are strong enough to withstand all the forces, and the reaction or pressure of the stationary rail *d* against the flanges of the wheels *h* acts as the external force to alter the direction of motion of the car and compel it

to keep on the curved part of the track.

In the example just illustrated, the car in running along the curved track swings about the center *e*, and the pressure of the outer rail inwards against the flanges of the wheels *h* holds the car on the track. If a long, strong rod were fastened to the side of the car at *i* and the other end of the rod were pivoted on a pin in the top of a heavy post set at the center *e*, then, as the car swung around the curve, the rod would keep the car from moving outwards away from the center and would hold it on the circular track. In such a case it would not be necessary to have flanges on the wheels *h*, because the rod would furnish the force that would be required to change the direction of motion of the car and bring it to a circular path. But in doing this there would be a very heavy pull on the rod and on the pin in the top of the post.

In every case in which a body moves or swings in a circular path about a point or a pivot, there is a tendency for it to move along a straight line tangent to the curve, as in Fig. 36, and therefore farther from the pivot. This tendency of the moving body causes what is commonly known as centrifugal force.

There are many other familiar examples that serve to illustrate the action just described. The mud that clings to the tire of an automobile wheel is thrown off when the wheel turns rapidly, and this action is due to the centrifugal force. A pail filled with water may be swung rapidly in a vertical circle, at arm's length, without spilling a drop, even though the pail may at times be upside down. The reason is that the water tends to move in a straight line away from the point about which the pail is being swung.

Large pulleys, such as are used in many kinds of machines, and the flywheels of engines that run at high speeds, have been known to burst and fly to pieces when they were turned too fast; in other words, the forces causing the tendency to move in a straight line were so great that the spokes or arms were not able to overcome the tendency, and as a result they broke under the strain and allowed the pieces to follow the straight lines along which they wished to move.

In the case shown in Fig. 36, it is the pressure or reaction of the rail *d* against the flanges of the wheels *h* that keeps the car moving in a circle.

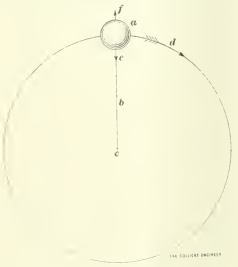


Fig. 37

When a rod is used, it is the pull of the rod that keeps the car to its circular path. When the pail of water is swung, the pull of the arm keeps it from moving away. In the pulley or flywheel the arms or spokes hold the rim to the hub and it is largely their pull that prevents the rim from breaking away. In every one of these cases, therefore, we find that there is a force acting on the moving body tending to push or pull it inwards toward the center around which it is swinging.

In the first case, the reaction of the rail supplies this force, and in the second case it is the pull of the rod. In the third, it is the pull of the arm that holds the pail, and in the last case it is the pull of the arms or spokes. This force that must be applied to a rotating body to keep it moving in a circle acts toward the center around which the body rotates and is known as the centripetal force.

The centrifugal force of a body is the reaction against the centripetal force, and as action and reaction are equal and opposite in direction, the centrifugal force is equal to the centripetal force in amount, but acts in the opposite direction. In other words, the centripetal force acts toward the center of rotation and the centrifugal force acts away from the center.

It is an easy matter to prove that these two forces must be equal. To do this, let us refer to Fig. 37, which illustrates a ball *a* that is held by a strong cord *b* to a pivot or center *c* and that is swinging in a circle about this center, as indicated by the arrow *d*. The centripetal force, which is furnished by the pull of the string, acts in the direction of the arrow *e*, or straight toward the center; and the centrifugal force acts in the direction of the arrow *f*, or straight away from the center. These two forces *e* and *f* must be equal. For, let us suppose for a moment that the force *e* is greater than the force *f*. Then the force *e* would overcome the force *f* and would push the ball closer to the center *c*. But this cannot be true, for the ball always moves along the circle, so that it is always at the same distance from the center. Also, the force *f* cannot be greater than the force *e*, for then the former would overcome the latter, the cord would be broken, and the ball would move away from the center. As the ball neither approaches the center nor moves farther from it, but stays always at the same distance, it is clear that the two forces must be exactly equal, so that one balances the other; otherwise the ball would certainly change its position with respect to the center.

In every case in which centrifugal force comes into play in a machine, the object is to make the holding parts strong enough to resist the effects of centrifugal force. If the weight of the body, the number of revolutions it is to make per minute, and its distance from the center of rotation are known, it is possible to calculate the centripetal force or the force required to hold the body at the desired distance from the center. But, as the centrifugal force is equal to the centripetal force, the rule is usually given to find the centrifugal force. The rule for calculating the centrifugal force of any rotating body is as follows:

Rule.—The centrifugal force of a rotating body, in pounds, is equal to .00034 times the weight of the body, in pounds, multiplied by the distance, in feet, from the center of rotation to the center of gravity of the body, and by the square of the number of revolutions per minute made by the body.

Example.—If a body weighing 10 pounds is rotated at 500 revolutions per minute and the distance from the center of rotation to the center of gravity of the body is 24 inches, what is the centrifugal force?

Solution.—The distance from the center of rotation to the center of gravity is 24 inches, or 2 feet. Applying the rule, then, the centrifugal force amounts to $.00034 \times 10 \times 2 \times 500^2 = 1{,}700$ pounds. Ans.

It is very much simpler to express the rule as a formula, in which case the centrifugal force becomes

$$F = .00034\ W\ R\ N^2$$

in which F = centrifugal force, in pounds; W = weight of body, in pounds; R = distance from center of rotation to center of gravity of body, in feet; N = number of revolutions per minute of body.

(To be Continued)

Mine Ventilation

Distribution of Air-Currents—Continuous Currents and Splitting—Overcasts, Different Methods of Construction

Written for The Colliery Engineer *(Continued from September)*

In the system of ventilating a mine known as the continuous current system, the air is conveyed in one unbroken current from the mouth of the intake through each one of the side, or cross-entries, in regular order, thence to the face of main entry and then, by way of the main return, to the fan.

Fig. 6 shows a plan of a mine opened on the double-entry system and ventilated by this method. The illustration shows three pairs of cross-entries on the right of the main entry (the workings on the left being omitted), the necks of the rooms only being indicated. By following the arrows, it will be seen that the air-current enters the mine through the main intake at I; turns into the room entry of the first pair of cross-entries, along which it travels to the last cross-cut; through this to the return and along it to the main intake, to be diverted into the second and third pairs of cross-entries, respectively. After completing the circuit of all the cross-entries, the current passes through the last cross-cut near the face of the intake into the main return and thence along it to the fan at R, where it is discharged into the outside air. The double lines in the cross-cuts between the main intake and return and the similarly placed single lines in the cross-cuts between the side entries represent brattices or stoppings built to confine the air-current in its proper course. It will be noted that the main intake is crossed at three places by dotted lines marked D. These indicate the position of the doors which must be placed across the main intake entry to force or throw the entering air up each pair of cross-entries.

The continuous current system was the earliest used method of ventilating mines and answered fairly well in the days of small mines and small output, but it does not serve at all under modern conditions, where the entries are often many miles in length and outputs of from 1,000 tons to over 4,000 tons must be had in 8 hours.

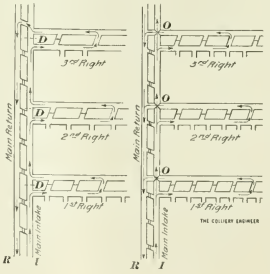


Fig. 6

Fig. 7

A little reflection will make clear some of the numerous bad features of this system. It is apparent that in a mine laid out as shown in Fig. 6 the main intake is the haulage road, consequently, any obstructions placed across it will materially interfere with the rapid haulage of coal and serve to reduce the output. Such obstructions are the three doors D, which are also a source of daily expense for attendants (trappers). Also, the excessive friction due to carrying all the current through many miles of workings (as in an extensive mine) may reduce its velocity at the innermost working faces to such an extent that it will not carry off the impurities generated by the operations of mining. A large fan may give sufficient velocity to remove these impurities, but the cost of building and operating such a fan is great and its use would probably result in dangerously high velocities of the air on the outermost entries.

But the chief objection to this method of ventilation is that the current gathers up the bad air, the gas, and the powder smoke from the first pair of cross-entries, carries them to the second pair where more foul air is gathered, which is carried on to the third and to any other pairs of cross-entries, and so on to the face of the main entry. The air, then, which enters pure at I, rapidly becomes impure in its journey through the mine, each entry receiving the combined impurities of all the entries outside it, until at the face of the workings the current might be so charged with powder and lamp smoke, carbon dioxide and the like, as to be either unbreathable or, if breathable, to contain so little oxygen as to be dangerous to health. In addition, in gaseous mines, the methane, which might be present in trifling amounts in each entry when taken alone, is rapidly increased in quantity as it is gathered up from each succeeding pair of entries, until an explosive mixture may

be produced. It is the steady increase in the amount of dangerous gases carried by the air combined with its steady decrease in velocity, together with obstructions to haulage caused by the doors, that renders the continuous current system of ventilation unsuited for large mines.

To overcome these objections a method of ventilation known as "splitting the air," or "splitting the current," is now almost universally employed in large mines. Under this system the doors are done away with and each pair of cross-entries receives a certain amount of fresh air and forms what is known as a split. Fig. 7 shows a mine ventilated in this way by three different splits, one for each pair of cross-entries. The arrows show the direction the air travels. It will be noted that at the mouth of each of the three-room entries the arrow forks, the fork curving into the cross-entry. This means that while the bulk of the air continues on along the main intake, a certain amount is split off from it and passes into the cross-entry which it travels to the last cross-cut and through it to the return cross-entry, and along this to the main return, where it joins the outgoing air from the inner workings of the mine. It will be noticed that at *O* the arrow is continuous across the main intake and is joined to the arrow which shows the direction of air movement in the main return. Furthermore, across the main intake at *O* is placed a mark ×. Both of these signs are used to indicate what is known as an overcast (shown in Fig. 8) by means of which and through which the return air-current from each pair of cross-entries (that is, from each split) is carried across or over the main intake into the main return. A little study of the plan will show the many advantages of this system of ventilation over the continuous current system first described. Each pair of cross-entries receives its own proper amount of fresh air from the main intake and delivers it through the overcast into the main return. Thus, the impure air from the first right is not carried into the second right nor is the bad air from these two entries carried into the third right, and so on throughout the mine, and, consequently, there is no concentration of the powder or lamp smoke, carbon dioxide, or methane, by means of

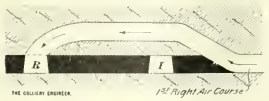


Fig 8

which the air on the inner entries of a mine ventilated upon the continuous current system is often unbreathable. On the split system, the air should be as pure and wholesome on the tenth pair of cross-entries as on the first.

Furthermore, the doors on the main entry are done away with, thus not only saving the wages of the trappers, but also, and more especially, by reason of the absence of obstructions across the track, permitting the hauling of a long trip of cars at the high speed which the large outputs of modern collieries demand. Again, the friction of the air is much less than under the continuous system of ventilation, and for this reason considerably less power is required to move the same volume of air than under the former method.

Overcasts.—Any device used to carry one current of air over another without intermingling is known as an overcast, air crossing, air bridge, or the like. In Fig. 8, *I* and *R* are the main intake and return entries shown in plan in Fig. 7, and it is required to get the air from the back heading of the first right entry across the main intake *I*, into the main return *R*. The figure shows the most solid and substantial, but probably the most expensive form of overcast that can

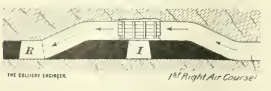


Fig. 9

be used for the purpose. It consists of a tunnel driven in the solid rock at a height above the entries depending upon the strength of the roof. If the roof is soft or easily weathers and falls, the distance from the roof of the main entries to the floor of the overcast must be greater than where the roof rock is solid. The overcast is driven of the same size as the entries which it connects, and at the points of connection therewith is curved to reduce the friction which a sharp bend would produce. It is a common practice, in order to save cost of handling, to stow the rock made in driving the overcast in the approaches thereto, thus reducing the size of the space through which the air has to pass. It is apparent that this should not be done, and this waste rock should either be dumped in an abandoned room or hauled out to the rock dump on the surface. Overcasts driven through the solid rock do not leak, and are not destroyed by an explosion.

If the expense of driving through the rock is too great or the roof is so poor that the overcast would be at an unreasonable distance above the entries, it is customary to make some kind of a box through which the air passes over, only shooting down enough roof to permit the box to be placed at a sufficient height above the rails so as not to interfere with the hauling. These box overcasts, when made of timber, are the commonest forms in use, and while the cheapest in first cost are the most expensive in repairs and almost always leak. Such a one is shown in Fig. 9. It should be noted that the drawing, while showing in cross-section the main intake and return and the first right cross-entry and the approaches thereto, gives the overcast proper in side elevation.

The floor beams spanning the entry may be made of any suitable lumber from 2 in. × 10 in. to 6 in. × 12 in., or even larger. The length of these beams should be a foot or two greater than the clear width of the entry, so that the box may be firmly supported upon solid coal. The greater the width of the entry the larger should be the floor beams, and the smaller the beams the closer are they spaced. The uprights, or studding, to which the side planks are nailed, are usually of the same size as the

floor beams; and the same is true of the joists which support the top of the overcast. In some cases the top (which is somewhat similar to the lid of a box) is omitted, the roof rock forming the top of the overcast. The floor, sides, and top (where the latter is used) are made of plank from 1½ inches to 2 inches thick. The ends and edges of the box where they come in contact with the coal or rock are plastered with clay, mortar, or cement to make an air-tight joint. To diminish the leakage of air, wooden-box overcasts are often lined with tongued-and-grooved flooring, between which and the outer planking is placed a layer of sail cloth or brattice cloth. As stated, wooden overcasts very commonly leak, largely due to the lumber adjusting itself to the atmospheric conditions prevailing underground. If the lumber is used when green (as is very commonly the case), and the mine is dry it will shrink and pull apart at the joints. If seasoned material is used it may swell in the dampness of the mine and shove apart at the joints. In either case, the overcast will leak.

An improvement upon the wooden overcast consists in making the floor beams of old rails weighing from 60 pounds to 80 pounds per yard. Rails of this size are not generally used around mines but may ordinarily be secured from the scrap heap of the railroad upon which the mine is opened. The larger rails are to be preferred to the smaller, particularly if the overcast spans a wide entry, as they are much stiffer. The rails are generally placed side by side with their bases touching and are then covered with a layer of concrete or cement from 2 inches to 3 inches thick. In other cases a flooring of ordinary red building brick or of coke-oven floor tile (firebrick 12 inches square and 3 inches thick) is first laid upon the rail floor beams and upon this is poured a grouting of cement. In still other cases the rails are placed not side by side, but from 4 inches to 8 inches apart, and the space between them filled in with bricks which are supported upon the bases and webs of the rail. Upon this foundation is laid a regular flooring of brick, tile, or concrete. Finally, the floor may be made of steel I beams filled in between with regular floor tile, the construction being the same as that used in the floors of fireproof office buildings, etc.

The sides may be made of brick, hollow building tile, or of concrete, and the latter may or may not be reinforced with steel rods or the like. The side walls are carefully covered with a plastering of cement. As the sides are built up to the roof rock and there plastered or cemented air-tight, no other roof than that of the mine is needed. Overcasts such as described, if well made, will last the lifetime of the mine, do not leak, and while costing more than a wooden overcast, soon save the extra cost in requiring no outlay for repairs.

The bottom of the floor beams should be placed at a greater height above the rail in the entry than the ordinary roof. Thus, if there is, say, 5 feet clearance between the rail and the natural roof, it would be well to place the floor beams 6 feet and even more above the rail. Overcasts are permanent structures and it may be that the track under them will at some future time have to be raised, in which case the overcast would have to be rebuilt unless originally placed at the height advised. Furthermore, if too low, a wreck on the haulage road beneath it might break it badly or cause it to leak. In either case it is apparent that any interference with the ventilation is a serious matter and may require the shut-down of the mine until the overcast is rebuilt at the new height in the first case or is repaired, possibly also rebuilt, in the second.

In the best modern practice the overcasts are built entirely of brick or stone masonry, or better and simpler, of reinforced concrete. The actual construction of such overcasts is comparatively simple, but the design and framing of the supports or "centers," as they are called, required to support the arches during erection is properly the work of the mining engineer.

(To be Continued)

New Belgian Coal Field

Of late there has been great activity in the search for coal in the new coal field discovered in the southern part of the Hainault province, and the number of borings made or in progress there amount to 75, covering almost all the region situated westward of the Sambre River, between the southern limit of the old basin of Charleroi, Centre, and Borinage and the French frontier. Recent investigations even suggest that this coal basin extends to French territory northwards of Jeumont and Maubeuge. A number of colliery companies have already applied for concessions. The most favorable results have so far been obtained in the district of Charleroi by the Courcelles Nord Co., and borings made at Bienne-lez-Happart, near Fountaine l'Eveque, have proved the existence of 20 seams of a thickness varying between .60 meter and 3.80 meters at a depth of from 665 meters to 970 meters.

The discoveries in the southern part of the Hainault province combined with those made in the Campine will dispel, it is claimed, any fears of coal exhaustion in Belgium for a century and a half. According to Professor Stainer, of Ghent University, it may be estimated that over 200 borings have been made in the country the last few years.—*London Times.*

卆 卆

United States Forest Service report that by means of planting shrubs and trees sand dunes are prevented from shifting by the winds. The most notable example of reclaimed sand areas is furnished by Golden Gate Park, San Francisco, where grasses, acacias, and later, trees and shrubs, have converted sand wastes into pleasure grounds a wealth-producing forest of marivof great beauty. At Landes, France, time pine, the source of the French turpentine, has been grown to take the place of shifting dunes, and the American foresters are experimenting with French maritime pine seed on the coast of Florida.

Answers to Examination Questions

Questions Selected from Those Asked at the Examination for Mine Manager, Mine Examiner, and Hoisting Engineer, Held at Springfield, Ill., January and April, 1913.

Note.—The numbers do not correspond with those of the Examination Questions as asked. After each question is given the nature of the examination, the number of the question, and the date at which held. M. M. = Mine Manager; M. E. = Mine Examiner; H. E. = Hoisting Engineer.

Ques. 1.—It was found that smoke traveled in an airway 6 feet high and 10 feet wide at the rate of 336 feet per minute. What was the quantity passing per minute? (M. E., 9, Apr.)

Ans.—The quantity of air passing is equal to the area of the airway in square feet multiplied by the velocity of the air-current in feet per minute, or $Q = a \times v = (6 \times 10) \times 336 = 60 \times 336 = 20{,}160$ cubic feet per minute.

Ques. 2.—We have 25,073 cubic feet of gas in the face on an entry, the barometer reading 30.7 inches. How would this volume be affected if the barometer falls to 29.9 inches? (M. M., 5, Apr.)

Ans.—As the temperature has not been changed, the volume of the gas will vary inversely as the pressure of the barometer; that is, since the pressure has decreased, the volume of the gas will be increased in the ratio that 30.7 bears to 29.9, or volume $= 25{,}073 \times \frac{30.7}{29.9} = 25{,}744$ cubic feet (very nearly).

Ques. 3.—There is 150,000 cubic feet of air passing into the mine; the water gauge is 2.1 inches. What is the horsepower? (M. E., 8, Jan.)

Ans.—The formula for the horsepower in terms of the quantity and water gauge, is $h = \frac{q \times 5.2 \times i}{33{,}000}$. By making the substitutions, we have,

$$h = \frac{150{,}000 \times 5.2 \times 2.1}{33{,}000} = \frac{1{,}638{,}000}{33{,}000} = 49.64 \text{ (nearly)}$$

Ques. 4.—We have a tank full of water in the morning when we commence work. We are using 1,300 horsepower per hour; how long will it take to empty the tank? The tank is 10 feet in diameter and 15 feet deep. (M. M., 19, Apr.)

Ans.—The volume of water in the tank is, V = area of base × height $= .7854 \ d^2 h = .7854 \times 10^2 \times 15 = 1{,}178.10$ cubic feet. At $62\frac{1}{2}$ pounds per cubic foot, the weight of the water in the tank is 73,434.9 pounds.

It is generally assumed, in calculations like this, that the development of 1 horsepower by the engines will require the evaporation at the boilers of 35 pounds of water per hour. To develop 1,300 horsepower would, thence, require the evaporation of $1{,}300 \times 35 = 45{,}500$ pounds of water an hour. As we have 73,434.9 pounds of water and use it at the rate of 45,500 pounds an hour, the tank will be emptied in $\frac{73{,}434.9}{45{,}000} = 1.614$ hours $= 1$ hour 37 minutes (about).

Ques. 5.—Give the weight of a boiler 6 feet in diameter, 16 feet long, with sixty-six 4-inch flues, the thickness of the steel being $\frac{1}{4}$ inch in the shell and ends of the boiler, and $\frac{1}{8}$ inch in the flues. (H. E., 6, Apr.)

Ans.—The area of the shell of the boiler is equal to the circumference multiplied by the length $= 3.1416 \times 6 \times 16 = 301.5936$ square feet. The thickness of the shell is $\frac{1}{4}$ of an inch or $\frac{1}{4 \cdot 8}$ of a foot; hence, the volume of the shell which is equal to the area times the thickness is $301.5936 \times \frac{1}{4 \cdot 8} = 6.2832$ cubic feet.

The total area of the two ends of the boiler is $2 \times (6^2 \times .7854) = 56.5488$ square feet. From this must be deducted the area of the metal cut out by the ends of the tubes. As the tubes are 4 inches in diameter, which is equivalent to $\frac{1}{3}$ foot, the total area cut out by them is $2 \times (66 \times .7854 \times [\frac{1}{3}]^2) = 11.5192$ square feet. The net area of metal in the ends of the boiler is, thence, 56.5488 square feet $- 11.5192$ square feet $= 45.0296$ square feet. The volume in the ends is $45.0296 \times \frac{1}{8} = .9381$ cubic foot ($\frac{1}{4}$ inch $= \frac{1}{4 \cdot 8}$ foot).

The area of metal in the flues is equal to 66 times the circumference of the flue times the length $= 66 \times 3.1416 \times \frac{1}{3} \times 16 = 1{,}105.8432$ square feet. The volume of the metal in the flues is equal to the area times the thickness, which is $\frac{1}{8}$ inch, or $\frac{1}{9 \cdot 6}$ foot, or $1{,}105.8432 \times \frac{1}{9 \cdot 6} = 11.5192$ cubic feet.

The total volume of metal in the boiler is, thence, $6.2832 + .9381 + 11.5192 = 18.7405$ cubic feet. At 489.6 pounds per cubic foot this quantity of steel will weigh $18.7405 \times 489.6 = 9{,}175.35$ pounds, or 4.58768 tons.

Ques. 6.—If the water gauge placed in a door 4 feet 6 inches by 5 feet shows a reading of 2.5 inches, what is the total pressure on the door? (M. E., 15, Jan.)

Ans.—Since the pressure per square foot due to 1 inch of water gauge is equal to 5.2 pounds, the pressure per square foot produced by a water gauge of 2.5 inches is equal to $5.2 \times 2.5 = 13$ pounds. As the area of the door is $4.5 \times 5 = 22.5$ square feet, the total pressure upon it = area × unit pressure $= 22.5 \times 13 = 292.5$ pounds.

Ques. 7.—The temperature in a mine is 65° F., the velocity of the air-current is 330 feet per minute, the

airway is 5 feet high and 9 feet wide. What is the weight of air passing in 1 minute? (M. E., 10, Jan.)

Ans.—The quantity of air passing is equal to the area of the airway multiplied by the velocity, or $q=(5\times9)\times330=14{,}850$ cubic feet a minute.

The weight of 1 cubic foot of air, assuming the barometer to be at 30 inches of mercury, is found from the formula

$$\text{Wt.}=\frac{1.3273\times30}{460+65}=.07585 \text{ pound}$$

From this the total weight of the air passing per minute is $14{,}850\times.07585=1{,}126.37$ pounds.

Ques. 8.—Does a high water gauge always indicate a large quantity of air passing? What does a low water gauge with a large quantity of air passing indicate? (M. M., 13, Apr.)

Ans.—No; in all cases a high water gauge indicates high resistance to the passage of the air and this is very often due to narrow, crooked and obstructed airways, and not to the passage of a large quantity of air.

A low water gauge with a large volume of air passing indicates little resistance to the passage of the air. Under these conditions the airways are of good cross-section, are kept clean and are straight. The airways may be long or short, as the terms low and large, are only relative, but they are in good condition.

Ques. 9.—A shaft 500 feet deep is full of water; what is the pressure per square inch and per square foot at the bottom of this shaft? (M. M., 12, Jan.)

Ans.—As the weight of a cubic foot of water (that is, a volume of 1 square foot in area and 1 foot high) is $62\frac{1}{2}$ pounds (nearly), the pressure per square foot on the bottom of the shaft is $500\times62\frac{1}{2}=31{,}166\frac{2}{3}$ pounds.

As there are 144 square inches in 1 square foot, the pressure per square inch is $31{,}166\frac{2}{3}\div144=216.44$ (nearly) pounds. The same result may be had by multiplying the depth of the shaft by .433 pound, the weight of a column of water 1 inch square and 1 foot high, thus, $500\times.433=216.5$ pounds.

Ques. 10.—An entry is parallel to a land line and 150 feet from it. If the rooms turned off the entry run at an angle of 45 degrees with the entry, what distance can they be driven? Allowing a barrier of x feet to comply with the mining law. (M. M., 15, Apr.)

Ans.—The law of Illinois requires that a pillar 10 feet thick be left between the face of the workings and

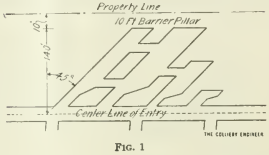


Fig. 1

the property line. Hence, the rooms may be driven $150-10=140$ feet from the center line of the entry, and at right angles thereto, see Fig. 1.

We have, thence, to find the hypotenuse of a right-angled triangle in which the other angle is 45 degrees and the side adjacent to it is 140 feet. The formula is

$$\text{Hypotenuse}=\frac{\text{side adjacent}}{\cos\text{ angle}}=\frac{140}{\cos\ 45^\circ}$$

$$=\frac{140}{.70711}=197.99 \text{ feet}$$

That is, the rooms may be driven 197.99 feet from the center line of the entry.

Ques. 11.—The area of the piston of an engine is 500 square inches, the mean effective pressure is 30 pounds per square inch, length of stroke 8 feet, and the engine is making 20 strokes per minute; calculate the horsepower developed. (H. E., 7, Jan.)

Ans.—By substitution in the well-known formula for horsepower, we have,

$$\text{Hp.}=\frac{p\ l\ a\ n}{33{,}000}=\frac{30\times8\times500\times20}{33{,}000}$$

$$=72.73, \text{ nearly.}$$

In this formula l = the length of stroke in feet; a = area of cylinder in square inches; n = number of strokes per minute; and p = the mean, or average pressure upon the piston throughout its entire stroke. This is not the pressure indicated by the steam gauge, as steam is commonly used expansively. That is, steam is admitted at the beginning of the stroke at full gauge pressure (say 90 pounds) and at one-fourth or one-half stroke (varying with the engine) the steam is cut off and through the rest of the stroke is rapidly falling in pressure. At the end of the stroke the steam pressure is commonly about that of the atmosphere, but in condensing engines it is less than that.

Ques. 12.—In an explosion of gas at 70° F., what would be the difference of expansion in volume, the combustion taking place at 9,564° F.? (M. M., 9, Jan.)

Ans.—The formula for the relative increase in volume is, relative increase $=\frac{460+T}{460+t}$, in which T is the higher and t the lower temperature. Substituting, we have, relative increase

$$=\frac{460+9{,}564}{460+70}=\frac{10{,}024}{530}=18.91+.$$

That is, the volume of the gases will be increased about 19 times.

Note.—This question is decidedly theoretical. It is apparent that such a temperature as 9,564 degrees cannot exist (if attained at all) for more than a very minute fraction of a second of time. The highest temperature used today is that of the electric furnace in which carborundum is made, where temperatures of from 7,000 degrees to 7,500 degrees prevail. This temperature of 9,564 degrees is more than three times the melting point of slate (2,800 degrees), nearly four times the boiling point of steel (2,456 degrees), and more than double the melting point of platinum. Should such a temperature as this prevail for any length of time or through a moderate sized body of gas even, not only would the rails, coal and roof be melted, but volatilized as well

Ques. 13.—What number of bricks are required to line a shaft 14 feet in diameter, 720 feet deep, with 18-inch walling? (1,000 bricks = 3 cubic yards.) What will the bricks cost at $7.50 per 1,000? (M. M., 15, Jan.)

Ans.—The clear, or inside, diameter of the shaft is 14 feet -2×18 inches $=11$ feet, since the thickness of the lining must be deducted from each end of the outside diameter to get the inside diameter of the shaft. The volume of the lining is the difference between the volume of a cylinder 14 feet in diameter and 720 feet long and one 11 feet in diameter and 720 feet long. While the contents of these cylinders may be calculated separately and the difference taken, it is simpler to combine the

figures. Thus, volume of lining $=.7854\ (D^2 - d^2) \times 720 = 42{,}411.6$ cubic feet $= 42{,}411.6 \div 27 = 1{,}570.8$ cubic yards. Since each 1,000 brick occupy a space of 3 cubic yards, there are $1{,}570.8 \div 3 = 523.6$ M brick; 523.6 M brick at $7.50 per M will cost $523.6 \times \$7.50 = \$3{,}927$.

Ques. 14.—If the ventilating fan is running at 80 revolutions per minute with 3.75 inches of water gauge, and the speed is altered so that the water gauge reads 1.82 inches, what will be the fan speed? (M. M., 8, Jan.)

Ans.—It is generally assumed that the yield of a fan is in proportion to its speed, or the number of revolutions per minute made by it. As the water gauge is proportional to the square of the quantity, and the quantity (as stated above) is proportional to the number of revolutions of the fan, it follows that the water gauge is proportional to the square of the number of revolutions of the fan. From this, using the values given in the question, we have $80^2 : x^2 = 3.75 : 1.82$. Whence $x^2 = \frac{1.82}{3.75} \times 80^2$, and $x = 55.7$, say, 56 revolutions per minute.

These results are not exactly in accord with those obtained from actual practice, from which we learn that the eighth power of the speed ratio is equal to the fifth power of the pressure (water gauge) ratio. From this $\frac{(80)^5}{x^8} = \frac{3.75^5}{1.82^5} = (2.06)^5$. Transposing, $x = \frac{80}{\sqrt[8]{2.06^5}}$, whence $x = 50.92$, say 51, revolutions per minute. This latter solution requires the use of logarithms, and as the difference in the result is but one revolution, it is apparent that the first and easier method is accurate enough.

Ques. 15.—A slope dips 1 foot in 12 feet for a distance of 756 feet, measured on the slope. What is the difference in elevation between the mouth and face of the slope, and what is the horizontal distance between them? (M. M., 9, Apr.)

Ans.—As the slope dips 1 foot in 12 feet, the dip in 756 feet will be $756 \div 12 = 63$ feet. Then in the triangle $A\,B\,C$, Fig. 2 we have the length of the side $A\,C$ as 756 feet and the side $B\,C$ as 63 feet, and it is required to find the side $A\,B$.

This may be found from the well known relation that the square of the hypotenuse is equal to the sum of the squares of the other two sides, or $A\,C^2 = A\,B^2 + B\,C^2$, which by transposition gives $A\,B^2 = A\,C^2 - B\,C^2$, whence $A\,B = \sqrt{A\,B^2 - B\,C^2} = \sqrt{756^2 - 63^2} = \sqrt{567{,}567} = 753.37$. Thus, the difference in elevation be-

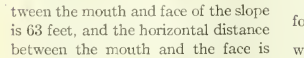


Fig. 2

tween the mouth and face of the slope is 63 feet, and the horizontal distance between the mouth and the face is 753.37 feet.

Ques. 16.—How many horsepower will it take to raise 60,000 gallons of water up a shaft 250 feet deep in 1 hour, resistance of pump and pipes being 25 per cent.? (M. M., 4, Apr.)

Ans.—Since 60,000 gallons are raised in 1 hour, there will be 60,000 $\div 60 = 1{,}000$ gallons raised per minute. At $8\frac{1}{3}$ pounds per gallon this will weigh $8{,}333\frac{1}{3}$ pounds. The horsepower is equal to the weight raised per minute multiplied by the distance through which it is raised, the product being divided by 33,000. From this, net horsepower $= (8{,}333\frac{1}{3} \times 250) \div 33{,}000 = 63.13$. But the resistance of the pump and pipes adds 25 per cent., or 15.78 horsepower, to this, making the total horsepower $= 63.13 + 15.78 = 78.91$ horsepower.

Ques. 17.—A pair of hoisting engines have cylinders 30 inches in diameter and a 60-inch stroke; the steam pressure is 90 pounds per square inch. How many revolutions per minute will they be running when generating 1,000 horsepower? (H. E., 8, Jan.)

Ans.—One horsepower equals 33,000 foot-pounds per minute, whence 1,000 horsepower equals 33,000,000 foot-pounds per minute. The area of the two cylinders equals $2 \times (.7854 \times 30^2) = 1{,}413.72$ square inches. In each revolution the piston travels twice the length of the stroke, or $2 \times 60 = 120$ inches $= 10$ feet. Then we have by substituting in the formula

$$\text{Rev.} = \frac{\text{foot-pounds per minute}}{\text{steam pressure} \times \text{area of cylinder} \times \text{length of stroke}} = \frac{33{,}000{,}000}{90 \times 1{,}413.72 \times 10} = 25.93,$$

say 26, R. P. M.

Ques. 18.—What will be a safe working load for a plow-steel hoisting rope $\frac{7}{8}$ inch in diameter? (H. E., 6, Jan.)

Ans.—Such questions as this are quicker and more accurately answered by reference to the tables to be found in the catalog of any manufacturer of wire rope. However, we may use the formula, $L = 44\frac{d^2}{f}$, in which L = safe working load in tons, d = diameter of rope in inches, and f = the factor of safety, which is commonly assumed at 5. By substitution, we have, (since $\frac{7}{8} = .875$), safe load $= \frac{44 \times (.875)^2}{5} = 6.74$ tons.

Ques. 19.—If 36,000 cubic feet of air is passing through an airway 6 feet by 10 feet, under a pressure of 3.6 pounds per square foot, what pressure is necessary in an airway 5 feet by 10 feet to pass the same quantity? (M. M., 11, Jan.)

Ans.—The first airway has an area of $6 \times 10 = 60$ square feet, and a perimeter of $2 \times (6 + 10) = 32$ feet. The second airway has an area of $5 \times 10 = 50$ square feet. and a perimeter of $2 \times (5 + 10) = 30$ feet.

The pressures vary directly as the perimeters and inversely as the cube of the areas, from which we have, calling the unknown pressure x, $\frac{x}{3.6} = \frac{30}{32} \times \left(\frac{60}{50}\right)^3 = \frac{15}{16} \times (1.2)^3$. From this, $x = 3.6 \times \frac{15}{16} \times 1.728 = 5.83$ pounds.

Ques. 20.—In pumping from a shaft 300 feet deep, with a steam pressure of 60 pounds at the shaft bottom, what should be the diameter of the steam end, if the diameter of the water end is 10 inches? (M. M., 18, Jan.)

Ans.—If we assume that the friction of the pipe is equivalent to increasing the depth of the shaft, or the head against which the pump works,

to 310 feet, the pressure against the pump will be $310 \times .433 = 134.23$, say 134 pounds (.433 being the weight of a column of water 1 inch high and 1 square inch in area).

If we assume an efficiency of .75 for the steam end, the effective pressure per square inch is $60 \times .75 = 45$ pounds. If we assume an efficiency of .85 for the water end, this is equivalent to decreasing the pressure to $134 \times .85 = 114$ pounds, about. Hence, we have a steam pressure (effective) of 45 pounds per square inch acting upon a piston x inches in diameter opposed by a water pressure of 114 pounds per square inch acting upon a water cylinder 10 inches in diameter. As pressures are proportional to areas upon which they act, and as areas are proportional to the squares of the diameters, it follows that pressures are proportional to the squares of the diameters of the steam and water ends. From this, $x^2 : 10^2 = 114 : 45$, when $x = 10\sqrt{\frac{114}{45}} = 16$ inches, about.

Mules

A good mine mule is worth $250 in northeastern Pennsylvania. In anthracite mines there are 15,625 of him, making an investment of $3,906,250. Although one seldom sees a dead mule the average life of a mine mule is but 5 years in anthracite mines, which means that $781,250 are expended yearly for mine animals to replace those that are killed. There has been no machine so far devised to replace the mule except where the hauls are long, and in this connection electricity, compressed air, and rope haulage have saved many mules' lives and are saving millions of dollars.

New Wrinkle in Cutting Coal

A new wrinkle in cutting coal, that works admirably under the conditions found at Weyanoke, has been hit upon by R. D. Patterson, Vice-President of the Weyanoke Coal and Coke Co., West Virginia. In machine mining elsewhere, the coal is undercut. The machine is run up to the place on a truck, unloaded, and fixed in position. When the cut is completed the machine must be laboriously loaded on to the truck again before it can be moved to the next place. Ten places of average width are about as many as can be cut in a day by a machine operated in the usual way.

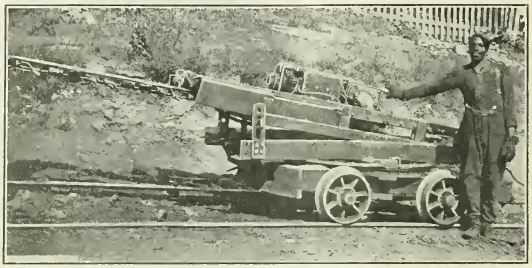


Fig. 1. Jeffrey Coal Cutter on Truck for Overcutting

In parts of the mine at Weyanoke, there is from 4 to 7 inches of draw-slate lying between the coal and the roof. It was to get rid of this draw-slate most easily and thoroughly that the new way of cutting coal was devised. A Jeffrey coal cutting machine was loaded on a home-made truck in such a position that it would cut into the coal just under the draw-slate at an angle of 20 degrees. This angle is just right to enable the miner to get rid of the slate easily and to allow a properly placed charge of powder to break the coal up into nice blocks. By overcutting the coal the "bug dust" from the machine practically takes care of itself. As the machine is never taken off the truck, it will cut an average of 15 places a night instead of 10, the average in undercutting. Besides, in overcutting there is no bottom left to be taken up laboriously by hand as in undercutting. But the most interesting thing about overcutting is that it reduces the cost one-half. Formerly the company paid 20 cents a car for cutting; now it pays 10 cents.

National Conservation Congress

The next annual meeting of the National Conservation Congress will be held in Washington, D. C., November 18, 19, and 20. One of the important factors in the executive committee's selection of Washington was the fact that the National Capital is the headquarters of the National Conservation Association. The Congress and the association are working in close and complete harmony, and this made the committee feel that it was desirable to have the year's activities of the two bodies culminate in an enthusiastic gathering of the Congress at their common point of concentration. It was agreed by representatives of both organizations that great benefit for the cause of conservation could be gained by having the congress assemble in Washington. As the center of the conservation work, the capital city affords exceptional facilities for the deliberation of the congress because of the immediate availability of the experts and statistics in the government's work along these lines.

Eckley First-Aid Team

The Eckley first-aid team of the Lehigh Coal Co. saved the lives of 7 men who had been overcome by powder fumes. The team consisted of Henry Jahne, James Berbeck, Frederick Monk, and Herman Feisner.

NEW MINING MACHINERY

Graphite Lubrication

Friction in machinery is not only a source of waste in power, but is also a source of loss in wear and tear in direct proportion to the amount of friction. In the case of steam engines, the least possible friction in the cylinders and valves with closest contact possible in the moving parts is an ideal condition. The specific cause of friction is the microscopic roughness of the sliding metallic surfaces. Ordinarily, oil reduces friction by forming a film between the sliding surfaces and preventing to some extent the contact between the minute projections. But oil lubrication alone has never been entirely satisfactory to mechanical engineers, so far as steam cylinders are concerned, because, even when oil lubrication is at its best, considerable friction remains or there is leakage of steam due to comparatively loose fits and to irregularities worn in the sliding parts. These add to the loss due to friction a further waste in steam, and the extra cost due to the generation of steam.

For many years pure graphite has been recognized as an ideal lubricant for steam cylinders and valves. But the trouble in the past was the difficulty in applying it. Mixed with oil, there was no certainty of it reaching all the desired parts, on account of the greater specific gravity of graphite. Again, the use of an excessive quantity of graphite in the oil, even when through agitation it was held in suspension, resulted in the plugging of the steam ports to a greater or less extent, and the undue accumulation of graphite on cylinder heads and piston heads.

The use of both graphite and oil as lubricants, if the graphite can be deposited and held in the proper places in exactly right quantities, reduces friction to a minimum, as the graphite lodges in the microscopic inequalities of the metal, and fills up all scratches and pittings so as to make the smoothest possible surfaces. This results in least possible friction, greatest efficiency from the engine, and greatest economy in steam consumption.

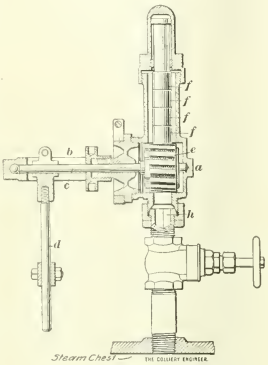


Fig. 1. Graphite Lubrication

A device which accomplishes this desirable end, known as the National Graphite Lubricator, has recently been put on the market by the National Graphite Lubricator Co., of Scranton, Pa., of which Mr. C. D. Simpson, who for many years was actively engaged in anthracite mining on a large scale as head of the firm of Simpson & Watkins, is president. As an extensive anthracite operator Mr. Simpson had practical experience in the cost of applying steam power in large quantities, and as a result of this experience both in the line of paying the bills and in studying the subject, he readily recognized the merits of the lubricator, which is the invention of L. S. Watres, who is vice-president of the company.

While these lubricators have only been on the market a short time, several large collieries and a number of industrial plants are using them. The West End Coal Co., at Mocanaqua, Pa., has 35 in use, the Lackawanna Coal Co., the coal department of the D., L. & W. R. R., has 20 in use at its National colliery, the Mt. Lookout Coal Co. has three on trial, the Harry E. colliery one, and Messrs. Jermyn & Co. have 26 in daily use at the Jermyn No. 1 mine, at Rendham, Pa.

Monthly Cylinder Oil and Graphite Consumption at No. 1 Jermyn Mine

Description of Machinery	Former Monthly Cylinder Oil Consumption. Gallons	Present Monthly Cylinder Oil Consumption. Gallons	Monthly Graphite Consumption Sticks	Percentage of Monthly Saving of Cylinder Oil
Duplex second-motion hoisting engine, 16 in. × 30 in., by Vulcan Iron Works, and one duplex breaker engine, 16 in. × 30 in. by same builder	20	8.0	112	60
Duplex second-motion hoisting engine, 16 in. × 30 in., by Dickson Mfg. Co.	6	3.0	52	50
Single fan engine, 16 in. × 30 in., by Dickson Mfg. Co.	4	2.0	30	50
Duplex tail-rope haulage engine, 16 in. × 30 in., by Finch Mfg. Co.	6	3.0	52	50
Duplex tail-rope haulage engine, 18 in. × 24 in., by Finch Mfg. Co.	6	2.5	52	58
Duplex second-motion hoisting engine, 18 in. × 24 in., by Finch Mfg. Co.	8	4.0	52	50
Single fan engine, 16 in. × 30 in., builder not known	2	1.0	60	50
Duplex second-motion hoisting engine, 16 in. × 20 in., builder not known	6	3.0	52	50
Duplex tail-rope haulage engine, 13 in. × 18 in., by Finch Mfg. Co.	6	3.0	52	50
Single fan engine, 16 in. × 30 in., by Finch Mfg. Co.	4	2.0	30	50
Single electric-light engine, 11 in. × 14 in., builder not known	12	6.0	30	50
Two Knowles duplex double-acting boiler feed pumps, 14-inch diameter, 10-inch stroke, 7-inch water piston	12	6.0	60	50
Two Jeanesville compound pumps, 3,500 gallons per minute capacity each, 20-inch high-pressure cylinder, 38-inch low-pressure cylinder, 48-inch stroke, 16-inch plungers	24	16.0	32	33

To get actual results of the use of the lubricators, a special representative of The Colliery Engineer went to the Jermyn No. 1 mine, saw the lubricators in operation, and obtained from the officials statements as to their merits.

Messrs. Jermyn & Co., as a trial, first installed two of the lubricators. The results obtained were so satisfactory that they have purchased and have in use 26, one lubricator being used for each cylinder of the duplex engines.

Mr. J. P. Corcoran, the mine superintendent, has kept accurate records of the oil consumptions of the various engines both before and after the installation of the lubricators, and he has kindly furnished the accompanying table showing the saving in cylinder oil. No accurate data as to increased efficiency in the engines, economy in steam consumption or in repairs were kept, but that these were of considerable importance is evidenced by the statements of the men in charge of each engine. In reply to inquiries made by our representative they each stated that the engines work smoother and handle the load easier.

In the use of the National Graphite Lubricator the graphite is not fed mixed with the cylinder oil. The lubricator delivers it continuously in a finely ground condition to the steam cylinders through the steam pipe or steam chest while the machinery is in motion. The graphite is supplied to the lubricators in cylindrical sticks about 1 inch in diameter and 1 inch long, the graphite being held in that shape by a special vegetable binder that does not affect its properties as a lubricant.

Fig. 1 shows a sectional view of the lubricator, and its operation is as follows: The body *a* of the lubricator carries a yoke *b* that forms one bearing for a shaft *c* which passes through a stuffingbox in the lubricator body and has clamped to it an arm *d*. This arm is hinged to some reciprocating part of the engine, usually a valve stem, and consequently is swung to and fro, thereby rocking the shaft *c* to and fro. Attached firmly to this shaft *c* is a grinding wheel *e* made of cast iron, with coarse carborundum grains firmly fixed to its periphery. The graphite sticks *f* are contained in a cylinder forming part of the lubricator body, and are fed down on the grinding wheel by gravity, the pressure being regulated automatically. The finely ground graphite drops down into the nipple *h*, from which it is fed in small quantities into the steam pipe or steam chest; the lubricator is mounted so that the cylinder containing the graphite sticks is in a vertical position.

Ventura Fans

For about 4 years the American Blower Co., Detroit, Mich., has been developing a new curved blade disk fan, and has obtained some wonderfully high mechanical efficiencies, be-

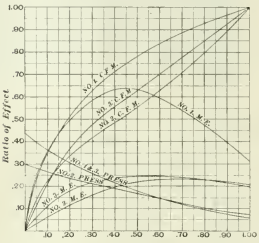


Fig. 2

sides retaining every quality that should make the fan attractive to users. This new fan is called the "Ventura." It has 10 broad blades of the proper dip or curve to produce large volumes freely or against pressures and so efficiently that the power consumption is away below the usual. Patents on the constructional features have been applied for.

The "Ventura" fan runs at speeds as high as any other fan of the disk type, if not higher, has remarkable capacity to overcome resistances, and throws an air-current straight ahead. In fact, the air as it leaves the fan has a tendency to bend inward for a considerable distance before it begins to expand. This is contrary to the action of any other disk fans. To illustrate this feature, the manufacturers state that one of these fans can be set 16 inches away from a hole in a box and discharge more air on the other side of the opening than the fan itself handles, due to the siphon action of the air as it passes through the opening drawing in air along the face of the box.

The accompanying chart Fig. 2 shows the relative capacity and mechanical efficiency of the "Ventura" fan as compared with two of the best known makes of propeller type fans used extensively.

Curve No. 1 shows the "Ventura" fan. Curves Nos. 2 and 3 are of the other fans. These curves were plotted from exhaustive tests under like conditions by the representatives of the American Blower Co.

Particular attention is called to the mechanical efficiency of "Ventura" fans, which runs as high as 64 per cent., whereas the best of the other two types shows a maximum of 24.5 per cent., and the other 23 per cent. maximum.

TRADE NOTICES

Electrical Equipment.—The General Electric Co. will furnish the following electric equipment:

The Locust Mount Coal Co., Shenandoah, Pa., six motors ranging from 20 to 125 horsepower; nine transformers ranging from 20 to 200 kilowatts, with switchboard panel and accessories. The Independent Coal and Coke Co., Salt Lake City, Utah, a 500-kilowatt alternating-current generator with switchboard. The Stag Cañon Fuel Co., Dawson, N. Mex., a 1,250 kv-a. Curtis turbo-generator, two 200-kilowatt rotary converters, with transformers, switchboard, and accessories. The Greensburg Coal Co., Greensburg, Pa., a 300-horsepower induction motor with transformers, limit switches, etc. The Crescent Coal Co., Evansville, Ind., a 5-ton electric mining locomotive. The Monon Coal Co., Terre Haute, Ind., a 10-ton electric mining locomotive. The Worth-Husky Coal Co., Bicknell,

Ind., a 6-ton electric mining locomotive. The Watkins Coal Co., Barnesboro, Pa., a 10-ton electric mining locomotive. The Butler Junction Coal Co., at Butler Junction, Pa., a 180 kv-a. motor generator set with 5-kilowatt exciter, switchboard panel, and a 6-ton electric locomotive. The Berwind-White Coal Mining Co., a 200-horsepower induction motor and starting compensator. The Ayrshire Coal Co., Ayrshire, Ind., two 5-ton electric mining locomotives.

Trolley Lubrication.—The following is an extract from a letter received by the Jos. Dixon Crucible Co. from the Lake Shore Electric Railway Co.: "We manufacture our own trolley wheels and they are constructed with an extra large chamber for lubricant, and have a graphite bushing for a $\frac{5}{8}$-inch pin, 2 inches long only. We take Dixon graphite cup grease No. 2 and thin it slightly with oil, making it somewhat thinner in the winter than in the summer. This lubricant is forced into the chambers of the wheel with a force pump in our shop and the wheel is then put into the harp attached to the pole and is ready for service; this is all the lubrication that is required for the life of the wheel. In the majority of cases we use the bushing over again on the second wheel. On trial equipments we have operated trolley wheels for 7,000 and 8,000 miles; however, in figuring up our average mileage on trolley wheels by the year, taking into consideration wheels that are lost, broken, and in some cases stolen, our average mileage is approximately 4,000 miles.

Rail Bonds.—The Ohio Brass Co. announce that they now manufacture all-wire rail bonds with pin-driven terminals. All types and forms of bonds, which formerly were furnished with compressed terminals, are now furnished in addition with the pin-driven terminals. The new bonds have embodied in them the same features which have characterized the older types; namely, terminals and body made of the same strands and the strands protected by thin copper sleeves at the point where they are welded together to form the terminal.

Safety First.—The Stonehouse Enameled Steel Sign Co., of Denver, Colo., the originators of the "Universal Danger Signal," have copyrighted a "Safety First" sign for use by those interested in the movement for the prevention of accidents. They propose to make these signs on paper, cloth, or iron in any size desired. They will also furnish "Safety First" buttons and will furnish cuts of the

Fig. 1

design for use on stationery, etc. The design, as shown in Fig. 1, is striking and sure to attract attention.

Modern Coal Handling Plants. The Belmont Coal Mining Co. is remodeling the surface plant of its Glenco mine, Belmont, Ohio. The car haul which extended into the mine is being replaced by a shorter and steeper one, which has the advantage of keeping all the machinery on the outside where it is accessible and can be better taken care of. The electric locomotives will now bring the cars out of the mine through another opening made for the purpose, delivering them to a chain car feeder which delivers them regularly to the car haul. The haul is 116 feet long on 35-per-cent. grade delivering two to three cars per minute. Mary Helen Coal Co., of Hatfield, W. Va., is installing a retarding conveyer to take the place of its present system. It is of the rope-and-button type, 150 feet long on slope of 33 degrees, with a capacity of 60 to 100 tons per hour. Davis Colliery Co., of Elkins, W. Va., is remodeling the tipple at Coalton mine with the idea of preparing lump and egg coal. Shaker screens separate the sizes, delivering the lump and egg coal to separate picking tables located over the railroad tracks, running longitudinally with them, and loading into the cars over adjustable booms, thus eliminating breakage. The nut and slack sizes are used for coking. A Bradford cleaner is being installed to improve the quality of these sizes. All the above equipment is furnished by the Fairmont Mining Machinery Co., Fairmont, W. Va.

Chemicals.—Roessler & Hasslacher Chemical Co., of New York City, furnish descriptive literature, prices, and detailed technical information on the chlorine derivatives of ethylene and ethane, the non-inflammable solvents used in the extraction of materials containing fats and oils, and in dissolving gums, rubber, and resins. They are also putting on the market Trisalyt, which combines the metal cyanide and the conducting salts for electroplating.

Coal Cleaning Machinery.—Colonel L. E. Tierney, president of the Tierney Mining Co., at Stone, Pike County, Ky., has awarded to the Link-Belt Co., of Philadelphia, a contract for complete tipple equipment and apron retarding conveyer. The tipple consists mainly of apron conveyers, shaking screens, electrically operated loading booms and combined mixing and refuse disposal; and practically every combination of the various coals, as well as all the separate sizes, can be produced. Amongst other apparatus, is an 8-foot double-balanced Link-Belt shaking screen. The Link-Belt Co. also will furnish the Castle Gate Coal Co., at Castle Gate, Utah, a shaking screen and picking equipment, including a Link-Belt rotary tipple; the Winona Coal and Coke Co., of Ruffsdale, Pa., a retarding conveyer and shaking screen equipment for their new tipple at Coffman, W. Va.; the Standard Coal Co., Salt Lake City (near Helper), Utah, a complete shaking screen and conveying equipment, including a new type revolving dump and rescreening equipment; the entire supporting structure will be of concrete.

Mine Car Grease.—A new mine car grease that is not affected by either heat or cold is now being put on the market by the Tropical Oil Co., of Cleveland, Ohio. It is called Toco mine car grease, and the manufacturers claim for it that while its lubricating qualities at ordinary tem-

peratures are equal to the best, it is especially valuable in places subject to either high or low temperatures or great variations of temperature. The same firm also furnishes a grease injector of such construction that the grease can be applied to roller bearings without taking them down.

Coal Laboratory.—For the convenience of their clients, the Roberts and Schaefer Co., of Chicago, have opened a laboratory for analyzing and testing fuels. The service they are prepared to render includes complete coal analyses and British thermal unit determinations; tests of the sizing, washing, and briquetting of coal; recommendations on method of taking coal samples; and reports on proper way to clean coal for market. A practical coal man and chemist, who has specialized for years in fuel testing, will have charge of this new department.

Catalogs Received

Davis Instrument Mfg. Co., 110 W. Fayette Street, Baltimore, Md Circular, Pocket Mining Hygrometer; Circular, American Anemometers.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Pneumatic Riveting, Chipping, Calking, and Stone Hammers, 24 pages.

William Powell Co., Cincinnati, Ohio. Circular, "Do You Use Air?"

Samson Mfg. Co., 1738 Broadway, Denver, Colo. Catalog No. 4, The Samson Crusher, 11 pages.

National Pulverizer Co., 1738 Broadway, Denver, Colo. Catalog No. 2, The National Pulverizer, 8 pages.

Hockensmith Wheel and Mine Car Co., Penn Station, Pa. Catalog, 32 pages.

American Fuel Saving Co., 1255 Leader-News Bldg., Cleveland, Ohio. Fuel Saving, 13 pages.

Builders Iron Foundry, Providence, R. I. Bulletin No. 72, The Largest Water Meters in the World, 12 pages; Bulletin No. 95, The Venturi Meter, 30 pages; Bulletin No. 56, Measuring Water, 47 pages; Bulletin No. 68, Venturi Hot Water Meter, 15 pages; Bulletin No. 73, "Slip" of Pumping Engines, 4 pages; Bulletin No. 71, Special Venturi Meters at the Wachusett Dam, 4 pages.

Fred M. Prescott Steam Pump Co., Milwaukee, Wis. Prescott Pumping Machinery, 164 pages.

National Tube Co., Frick Bldg., Pittsburg, Pa. The Whole "Kewanee" Family, 48 pages.

Sullivan Machinery Co., 122 South Michigan Avenue, Chicago, Ill. Bulletin No. 58-N, Sullivan Small Air Compressors, 15 pages.

Edgar Allen American Manganese Steel Co., McCormick Bldg., Chicago, Ill. Steam Shovel and Dipper Dredge Repair Parts, 19 pages.

Wheeling Mold and Foundry Co., Wheeling, W. Va. List of Parts of Wheeling Forced Feed Crusher, 18 pages.

Warwood Tool Co., Wheeling, W. Va. Coal Miners' Tools, 12 pages.

Morris Machine Works, Baldwinsville, N. Y. Catalog covering Standard Pumps and a few Special Centrifugal Pumping Outfits, 126 pages.

Asbestos Protected Metal Co., Beaver Falls, Pa. Asbestos Steel for Roof and Walls, 24 pages.

The Hess Bright Mfg. Co., Philadelphia, Pa. Circular, Ball Bearings and Their Correct Use.

Milwaukee Locomotive Mfg. Co., Milwaukee, Wis. Publication No. 104, Milwaukee Gasoline Locomotives, 40 pages.

The Ohio Brass Co., Mansfield, Ohio. Construction Notes on Electrical Transmission in Mines, 26 pages.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y. A Question of Drill Bits, 22 pages.

Jeffrey Mfg. Co., Columbus, Ohio. Bulletin No. 118, The Care and Operation of Jeffrey 28A Shortwall Mining Machine, 24 pages.

Blake & Knowles Steam Pump Works, 115 Broadway, New York, N. Y. Blake-Knowles Single Pumps, 84 pages.

The Bristol Co., Waterbury, Conn. Condensed Catalog No. 160, Bristol's Recording Instruments, 64 pages; Bristol's Class II Recording Thermometers, 48 pages.

Pennsylvania Notes

The property of the Frugality Coal and Coke Co., which has been operated at Frugality, one of the oldest mining towns in Cambria County, for a number of years, has been taken over by the bondholders and the mines put in operation under the management of F. P. McFarland, of Altoona. The name of the town has been changed to Erdon, but the railroad company and the postal authorities have given it the name by which it is best known, Frugality.

The Blubaker Coal Co., of Spangler, one of the largest land-holding and operating companies in Cambria County, has commenced the opening of a new mine on Byrnes Run, near Barnesboro. A field of 1,000 acres of coal will be developed and the output shipped over an extension of the Walnut Run Branch of the Pennsylvania Railroad.

The Penn Central Light and Power Co., who have electric lines throughout Cambria County, and who have a contract for furnishing power for all of the mines of the Pennsylvania. Coal and Coke Corporation, have recently built a substation at the Amsbry mine. They are also furnishing power for the mines of the Portage Coal Mining Co., Colonial Coal Co., George Pearce & Sons, and other operators on Martins Branch of the Pennsylvania Railroad. The Springfield Coal Mining Co. are also arranging for installation of Penn Central power at their slope near Nant-y-Glo, which it is proposed to use for haulage, and also for cutting their coal with electric mining machines. The Springfield Coal Mining Co., who recently had a serious fire at their mines, burning their stable and mine mules, have decided to abandon the use of mules in haulage and install electric locomotives for this purpose.

The Colliery Engineer

Formerly Mines and Minerals

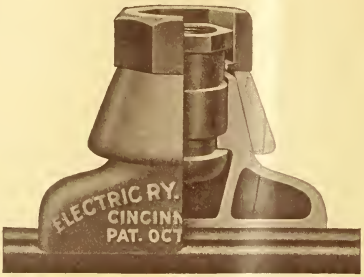
LIBRARY
NOV 4 1913
UNIVERSITY OF

Vol. XXXIV—No. 4 NOVEMBER, 1913 Scranton, Pa.

Alphabetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68

A Women's First-Aid Team



"SURE GRIP"

"Sure Grip" is not simply a trade name used to designate our particular brand of Trolley Clamps. It is also an absolute guarantee—it's a fact.

The "Sure Grip" Trolley Clamp is all its name implies.

It is so constructed that, once adjusted properly, it is simply impossible for it to work loose or to drop the wire.

This is but one of the features that has made the "Sure Grip" Trolley Clamps so popular in the mine field. Men in the workings feel absolutely secure when walking along passages where trolley wire is strung. They know that the wire **cannot** work loose and hang down, endangering their lives.

Made in all sizes from 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine and Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah Cleveland
(Office Atlanta)
San Francisco Los Angeles
Seattle Portland, Ore.

COPYRIGHT, 1913, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXIV—No. 4 NOVEMBER, 1913 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1881

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

CIRCULATION THIS NUMBER 13,000

TABLE OF CONTENTS

Editorial—
Editorial Notes—Our Cover Picture—Prosperity in the Coal Fields—The Same Old Story—Coal-Coal—The Passing of the Mine Mule—Alabama Coal Export—Professionalism—First-Aid Judging 197
Personals 200
The Connell Colliery Hospital 201
Fan Tests 206
First Aid to the Injured—
American Mine Safety Association, 207—Vandalia Coal Company, 210—Stearns Coal & Lumber Co., 210—H. C. Frick Coke Co., 210—Red Cross Muckle Cup Contest, 211—Knoxville First-Aid Meet, 212—Lehigh Valley Coal Co., 213—Victor-American Fuel Co., 214—Philadelphia & Reading Coal and Iron Co., 215—Susquehanna and Allied Companies, 216—Lehigh & Wilkes-Barre Coal Co., 216—Delaware, Lackawanna & Western Co., 219—Pennsylvania Bituminous First-Aid Meet, 220—Mine Rescue Crews in Kansas, 220—The Pennsylvania-Hillside Contest, 221—Lehigh Coal and Navigation Co. Field Day, 222—Bituminous First-Aid Movement 222
Correction 222
What is Coal Land? 224
Illinois Coal Statistics 225
Hydraulic Filling as Roof Support, by George Knox 225
West Virginia's Compensation Act 228
Unusual Accident 228
Mine Humidification, by Dwight Gerber 229
Strip-Pit Mining in Kansas, by Barry Scobee 232
Miner Entombed for Eight Days 233
The Cementation Process for Sinking Shafts 234
Miners' Vocational Schools 235
New Mine Safety Sign 236
Safety First, by Thomas Moses 236
Timely Suggestion 238
Underground Telephone Systems 238
Mine Accidents in Great Britain 238
The Ability of the Acetylene Flame to Show the Presence of Dangerous Gases in Mines, by E. M. Chance 239
Obituary—
Andrew Robertson 241
The Value of Coal Analyses, by N. W. Lord 242
Notes on Mines and Mining 244
Practical Talks on Coal Mining—
Mechanics of Mining, 246—Electricity in Mines, 247—Mine Ventilation 248
Examination Questions—
Mine Managers, Mine Examiners, and Hoisting Engineers, Springfield, Ill., January and April, 1913 250
Book Review 254
Prize Contest 256
New Mining Machinery—
The Breast Turret Coal Cutters, 259—Portable Air Compressors, 260—Rice Gasoline Rock Drill, 260—The Manierre Car Loader, 261—After the Fire 261
Trade Notices 261
Catalogs Received 262
Briquets of Coal and Naphthaline 262
Squibs—
Radium, 228—Barium Chloride Hardening, 241—Density of Water, 245—Coal Used for Coke Making 262

THE demand for Pocahontas coal now exceeds the supply, that is 2,500 miners are needed to dig the 1,500,000 tons that are in demand just at this time to supply the market.

IN a recent decision at Seattle, Wash., United States District Judge Cushman said: "Complaint is made that the strike breakers have been called scabs. The name 'scab' is calculated to provoke assault and this court cannot countenance any attempt to cause violence."

OLD "Pro Bono Publico" who years ago was constantly telling newspaper editors how to run their journals has left a lot of provincial lawyer, clerk, and preacher descendants in the anthracite region of Pennsylvania who are now trying to tell mining engineers and mine managers how to mine coal without leaving a hole in the ground.

ABILITY always has a front seat. The mine official with good ideas stored up in his brain is always in touch with the "big boss." He is the natural choice when promotions are made. Some good ideas are developed through personal experience Most of them, however, are accumulated through reading descriptions of successful methods originated by other mine officials and if possible improving them. The mine official who doesn't read doesn't advance. In most cases he goes backward and makes room for a more progressive man.

THE new tax on Pennsylvania anthracite is an additional item added to the cost of production. In the coal business as in all other well conducted commercial enterprises the selling price of a commodity is regulated by its cost. If the cost of production increases, the selling price also increases. In the case of anthracite, there is no cost item that can be cut to make up the tax. Therefore the additional cost of production is added to the selling price. This is a rational business proposition that will be indorsed by business men generally. Naturally, the increase has given yellow journals and muck raking magazine writers another chance to

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

yelp. These same fellows, if they had an opportunity to get a glimpse of Heaven, and could get a dollar or two for it, would write articles condemning that beatific place on the grounds that the harps were pitched on too high a key, and that the crowns glittered too much.

Our Cover Picture

AFTER our cover had been made, it occurred to us that it might better have been labeled a Second-Aid Team. It shows a woman's team attending to a boy who, it is presumed, fell out of a fruit tree, but the second-aid teams also do heroic work by helping the worn-out mother whose children are sick, or whose husband has been injured in the mines. Whoever originated this plan is entitled to be placed on the Roll of Honor.

Prosperity in the Coal Fields

PARKER and Bridge state that many miners boast a wardrobe of half a dozen suits, the average price of which is $40. With his tailor-made clothes, the miner often wears socks that cost $1 a pair, shoes that cost $6, and a hat at $3. The average price paid for neckties is 57½ cents and for shirts, $1.50. In short, the industrious miner in West Virginia is about the best dressed workman to be found anywhere. This accounts for the strikes on Paint Creek; the miners can't show their clothes if they work.

The Same Old Story

A SHORT time ago several newspapers in the anthracite region and in Philadelphia came out with the above head line over a news telegram stating that only one applicant had successfully passed the examination for mine inspector in a certain anthracite district.

It is only another case of these papers attempting to create a feeling of animosity against the present method of selecting State Mine Inspectors, so as to enable their editors to pose as a "friend" to the workingman at the mines.

Now for the facts. Beside the successful applicant, the present inspector, the only other man who made the 90 per cent. in his written examination as required by law, fell down miserably in his oral examination, and why? Because that man has not been able to obtain a position of trust at any anthracite mine in the region for more than 10 years, the reason being that he was superintendent in 1898 of a mine where six men met an untimely death in one accident due to his mismanagement. In the mine inspector's report of that district for the year 1898 we find the following statement by the inspector:

"I do not hesitate to say plainly that this disaster was caused by the misrepresentation and incompetent management of the superintendent in charge, whose previous training was not of such a character as to qualify him to take charge of a colliery of this kind. The condition of the colliery had been poor for 2 years before this accident, as is evidenced by records of my visits which have been frequent, and by correspondence relating thereto."

And yet with aspirants like that for an office of trust and importance, as is that of state mine inspector, these so-called "champions of the common people" without knowledge of facts attempt to create public opinion against the best possible means of securing competent men.

Coal-Coal

ABOUT 50 per cent. of the people who know better, and 100 per cent. of the people who do not know better, write about anthracite coal, which is equivalent to writing coal-coal. Anthracite is derived from the Greek word *anthrax* meaning coal and because of its close approach to a mineral or a definite chemical compound has been given the suffix "ite," while other kinds of coal are described by two words such as bituminous coal, brown coal, cannel coal, etc.

A mineral is neither animal nor vegetable, but an inorganic homogeneous substance found in nature.

Coal, not being a definite inorganic compound, but containing some organic matter, is not a mineral, although it has been mineralized by the addition of inorganic substances, and deprived of a large part of its organic substances by pressure. Anthracite has been changed so greatly by heat and pressure that it contains only small quantities of the original hydrocarbons belonging to the vegetation from which it was derived, and because of its luster, hardness, and chemical composition approximates a mineral.

The Passing of the Mine Mule

WITH the advent of each new kind of mine locomotive, some one has prophesied the passing of the mine mule from our midst. The Connell Anthracite Mining Co., of Bernice, Pa., has not a mule in its mine, all gathering and delivery of mine cars being accomplished by electric locomotives. It is necessary to wire some rooms for the locomotives, and to use a flexible cable in others; however, the work is accomplished without difficulty.

The Philadelphia & Reading Coal and Iron Co., has a storage-battery locomotive in operation at its Glendower colliery in the Heckscherville Valley that has been hauling long trips of cars with success.

The average life of a mine mule is said to be 4½ years and his probable cost $200. In the anthracite fields there are over 16,000 mules so that the elimination of the mule would be a long step towards economy in the cost of production.

Alabama Coal Export

THE first cargo of Alabama coal, loaded at Mobile, has been exported to Hayti. This is the start for Alabama coal exports, a proposition which, years ago held out sufficient inducements for some New Yorkers to drop considerable money and an adventurer lived for some years on the proceeds derived from hoodwinking northern people that it was possible to build a dock on the horn which encloses Mobile Bay, he claiming that it was a Spanish Grant which he controlled. The United States Government was found, however, to be in possession, and there was nothing doing until recently, when the channel has been deepened to Mobile.

Professionalism

AN OCCUPATION involving special education often so engrosses the mind that scarcely anything of an outside nature will arouse interest.

Persons who devote their entire attention to their professions, soon become "case hardened," and sometimes speak figuratively to express their desires. A coal operator who built a private hospital was told by a nurse that she hoped some one would get injured as she had not had a patient in four months. "Great Scott!" replied the operator, "I did not build this hospital to have people injured, but to have a place where, in case of an accident, the injured would receive proper care and get well." "I do not really want any one hurt," replied the nurse, "but I must have something to care for, so you might get me a cow and some chickens."

First Aid Judging

WHILE the layman is not competent to criticise the surgeon judges' decisions in a first-aid contest, he is at liberty to comment on the rules of the game.

The recognition of this right to free one's mind, is what saves one editorial writer from being bombarded with the bricks he anticipated for making the grossly offensive statement that "in the anthracite fields there is inadequate judging by competent judges," while in the bituminous field "adequate judging by incompetent judges prevails."

So far as can be learned, each company surgeon has ideas of his own relative to judging and marking, which is quite natural, when one considers the many complicated injuries that can be made further complex by a system of arbitrary rules which will change the conditions under which such problems are supposed to happen.

The primary object of first-aid contests is to stimulate interest in the work of caring for the injured, but when one team knows the rules, and the others are ignorant of them, it possesses an unfair advantage which may place it first on technicalities. Decisions rendered on technicalities based on a set of arbitrary rules, will, instead of stimulating interest, cause it to wane, and also will withhold entries from intercompany contests. From this perspective it would seem that the first duty of the American Mine Safety Association should be to standardize a set of rules for first-aid contests.

The system of discounts used at Knoxville and Pittsburg were those suggested at the first meeting of what is now termed the American Mine Safety Association. To make use of the eighteen different discounts would require a judge to each team, and reasoning from the fact that the schedule could not be used at the Pittsburg meet of the association in September, the inference is that the system is top heavy with demerits. Most of the discounts come under three heads, as follows:

1. Failure to do the most important thing first.
2. Improper handling of the patient.
3. Improper treatment of the injury.

The remaining discounts depend on these three, and consequently the judges should use their unbiased opinion in deciding the merits of the teams.

Practice and instruction perfect men in the technique of bandaging, but there is no necessity of tying knots or applying tourniquets to subjects so hard as to stop the circulation, as is often done; the point at issue is, have these been placed where they will solve the problem?

One accustomed to the game can tell from the way a baseball player handles the ball and bat and makes use of his limbs, whether he possesses more than average skill, and so it is with first-aid judges, especially in the anthracite fields, where most of the judges have been actively engaged in instructing first-aid teams.

At the Shamokin meet on September 13, 1913, three judges attended to 14 teams. These men were experts and agreed among themselves what three things each should look for on which to base discounts. Then one followed a short distance behind the other and walked about methodically among the teams.

Those who train the teams know which are the better; in fact, one doctor stated beforehand, at an intercompany meet, the order in which his teams should be rated. This was done in order to test the judges' skill. With one exception the judges' decision corroborated his, and that was where the teams were to improvise a stretcher, and his team, whose rating was lowered, used a regular stretcher.

It is unreasonable to assume that if the competent judges did inadequate judging, the surgeons doing the training would remain quiet, for it is to their interest to have their teams win, but they know the conditions better than any one else, from which it may be assumed they are satisfied, in fact, they will tell one so. The object of first-aid work is not to win prizes, but so long as there are intercompany contests held, this judging must be satisfactory to keep the movement from stagnating.

PERSONALS

John T. Fuller, formerly of Honesdale, Pa., has been appointed State Mineralogist and Mining Engineer, by State Commissioner John H. Page, of Arkansas.

Rudolf J. Schneider, mine foreman at the East Brookside colliery of the Philadelphia & Reading Coal and Iron Co., has been appointed inside district superintendent succeeding the late John Lorenz.

A. W. Calloway, General Manager of the Rochester and Pittsburg Coal and Iron Co., has been made vice-president and general manager of the Davis Coal and Coke Co.

A. H. Von Bayer, of Detroit, Mich., has succeeded H. M. Cole as superintendent of the new plant of the Solvay Coal and Coke Co., at Ashland, Ky.

J. A. Smith has been appointed superintendent of the Wellsbury, West Virginia, mine of the West Virginia-Pittsburg Coal Co. He succeeded Mr. James Virgin.

J. B. Allen, Chief Engineer of the Slemp Coal Co., has resigned his position to go with the Kentucky Block Coal Co., at Hazard, Ky.

Frank M. Fritchman, Manager of the McDonald mines of the Pittsburg Coal Co., has resigned that position to become the general manager of the Rochester and Pittsburg Coal and Iron Co. mines, succeeding A. W. Galloway, resigned.

The College of Engineering, University of Illinois, has appointed S. O. Andros, as Associate Professor in Mining Engineering. For the past 2 years Mr. Andros has been field assistant in the cooperative mining work which is being carried on at Champaign, by the United States Bureau of Mines, the Illinois State Geological Survey, and the University Department of Mining Engineering.

Major Charles Lynch, who has been so active in spreading first-aid work among coal miners, has been detached from the Red Cross Society and attached to the regular army. It is probable that he will be sent to the Philippines.

Owing to the death of President Cyrus H. Polley, of the Seneca and Punxsutawney Coal Mining companies, Harry Yates has been elected president, W. W. Campbell, vice-president, and William H. Nicol, general sales agent of those companies.

Governor McCreary, of Kentucky, appointed Raymond D. Clere as assistant state mine inspector, succeeding H. G. Van Hoose. The appointment took effect October 1.

T. A. Carraher has accepted the position of mine manager for the Benton Coal Co., Benton, Ill., succeeding J. P. Crouch, resigned.

The Summit Branch Mining Co., announces the appointment of John E. Davey and Charles Hoffman as mine foremen at the Short Mountain colliery, Lykens, Pa., succeeding John Thomas and Joshua Evans, retired.

Governor Dunne, of Illinois, has appointed James Forester, of Hallidayboro, and James Shaw, of Virden, as members of the Illinois State Mining Board, representing the operators and miners, respectively.

Francis Feehan, formerly president of District No. 5, United Mine Workers of America, which embraces the Pittsburg field, has been appointed supervising inspector by the State Commissioner of Labor and Industry. He will have charge of the western Pennsylvania district.

J. W. Blair, of the Neva Smokeless Coal Co., in Somerset County, Pa., has sold his interests in that company, and has taken a position as manager with the Roger-Corr Coal Co., at Nanty-glo, Cambria County.

J. O. Hannah, mining engineer of Calgary, is now with the Yellowstone Pass Coal Co., at Edmonton, Alta.

Dr. M. J. Shields has been traveling as far as the Pacific Coast, in the interest of first-aid work. He instructed a large number of miners at Spokane and Butte and some at the Great Falls smelters.

J. F. Healy, former general superintendent of Davis Colliery Co., Elkins, W. Va., has accepted the position of vice-president and general manager of the Consolidated Fuel Co., operating mines at Black Hawk and Hiawatha, Utah. Mr. Healy will have his headquarters in Salt Lake City.

Earl A. Henry, Chief Mine Inspector of West Virginia, announces the appointment of the following mine inspectors in that state. The districts assigned are in the order named: Karl F. Schoew, at Fairmont; Frank E. Parsons, at Clarksburg; L. D. Vaughn, at Grafton; W. B. Plaster, at Elkins; E. B. Cobb, at Montgomery; Enoch Carver and James Martin, at Charleston; R. Y. Muir, at Hinton; L. B. Holliday, at Beckley; Arthur Mitchell, at Bluefield; L. Blenkinsopp, at Welch; E. C. Lambert, at Williamson.

Paul Hardy, general manager of the Island Creek Coal Co., at Holden, W. Va., has been promoted to consulting engineer of the Pond Creek Coal Co., Island Creek Coal Co., and United States Coal and Oil Co.

William Alexander, of Ehrenfeld, Pa., has been appointed superintendent of the operations of the Pennsylvania Coal and Coke Corporation at that place, succeeding Edward Nicholson.

E. J. Berwind, president of Berwind-White Coal Mining Co., has been elected a director of the Erie Railroad, vice Mr. H. McK. Twombley, deceased.

J. W. Shook has resigned as vice-president and general manager of the Central Iron and Coal Co., of Tuscaloosa, Ala., effective November 1. He will be succeeded by W. L. Klutz, at present connected with the Republic Iron and Steel Co.

Robert Y. Anderson, Jr., for the past 10 months associated with the New York office of Weston, Dodson & Co., Inc., has been transferred to Morea colliery, Pa., as assistant to Vice-President A. C. Dodson, effective October 1. John F. MacIntosh will fill the vacancy.

The Connell Colliery Hospital

A Finely Equipped Hospital of Moderate Size Especially Adapted to the Needs of Isolated Coal Plants

Written for The Colliery Engineer

ONE of the four coal operations in Sullivan County, Pa., is that of the Connell Anthracite Mining Co. This company's headquarters are in Scranton, but its operation is at Bernice, Sullivan Coounty, on the Bowman's Creek Branch of the Lehigh Valley Railroad. The mine is developed at this time so as to ship about 1,200 tons daily, and has the probable distinction of being the only anthracite mine which has no animals inside and uses mechanical haulage entirely. It also has a further distinction, and that is that all coal is mined by machine; in fact, all mechanical work underground is carried on by electric power, even to pumping; there being two power pumps inside, of the Allentown make. Bernice is situated about 50 miles from Wilkes-Barre, and about the same distance from Sayre, the nearest towns having hospitals, and because of the infrequent train service, if a person needed hospital treatment, delays occurred which were injurious and might prove fatal. If a man was injured after 9:30 A. M., he could not be sent to a hospital until 6:10 P. M., and then probably 3 hours more time would elapse before his injuries could be properly attended to.

FIG. 1. CONNELL COLLIERY HOSPITAL

FIG. 2. WARD IN HOSPITAL

Hon. W. L. Connell, president of the company, determined to rectify this delay by building and equipping the Connell Colliery Hospital, which was dedicated September 2, 1913.

There have been but few hurt in the Connell mine. According to the Anthracite Mining Reports of Pennsylvania, for the period from 1903 to 1911, inclusive, there has been one fatal accident for every 116,000 tons of coal mined in the district in which the Connell mine is situated. During the same period this company has had but one fatal accident for every 248,665 tons mined, or more than double the district output for each fatality. Based on the number of employes engaged in and about mines the average fatality has been one for every 273 employed, for the district, while the Connell company had but one fatality for every 441 employed.

Mr. Connell having made up his mind to build a hospital for his employes, induced his brother, Dr. A. J. Connell, to outline a plan and consult with an architect, with the result that Bernice has one of the cleanest, up-to-date hospitals to be found in Pennsylvania. In view of the fact that many collieries are more unfavorably situated than the Connell colliery, so far as train service and hospital accommodations are concerned, the plans and specifications of the hospital were solicited from Mr. Connell and through his courtesy THE COLLIERY ENGINEER is permitted to offer them to its readers. Mr. Connell does not stop here, but is encouraging first-aid work, and intends to erect a similar hospital at Morton, W. Va., for the benefit of the Paint Creek Coal Co.'s miners, he also being president of that company. The erection of company hospitals is one more illustration of the good will and the sympathy that coal-mine operators entertain for their employes, and

carries out practically the parable of the "Good Samaritan."

A front elevation of the Connell Colliery hospital is shown in Fig. 1; Fig. 2 shows the ward room; Figs. 3 and 4 are two views of the operating room; and the plans and rear elevation are shown in Fig. 5.

When a patient is brought to the hospital the ambulance is backed to the receiving room door, the floor of which is on a level with the ambulance floor. The patient may then be removed without suffering due to jars, and placed on a movable table that may be pushed into the wash room where he can be undressed and washed prior to being placed in a bed in the ward room or being wheeled on a table to the operating room. From the two views of the operating room, Figs. 3 and 4, it may be seen that it is furnished with modern steel enameled furniture, comprising chairs, operating table, instrument stand, wash dishes, instrument cabinet, drug and bandage cabinet, water sterilizing plant, towel and bandage sterilizing apparatus, a dish and instrument sterilizing box, and a supply closet. The room is large and well lighted by day and at night by electric lights. The ward room contains six cots, but if occasion demanded, the bed rooms on the second floor could be arranged to receive six more patients.

The second-floor plan shows the arrangement of the bed rooms and the nurses' sitting room and bath room. If the best way to prevent war is to build battleships and be prepared for it, why should it not follow that the best way to prevent death from injuries is to be prepared to treat them? So far the nurse has had 4 months without a patient, and feels as if she was not earning her salary. The doctor, however, is able to keep busy among the people in Bernice and the vicinity, so that loneliness is not apt to affect him. The location of the hospital is on a knoll where there is a view of the town of Bernice and the town of Mildred, a short distance away. Bernice seems more like a country village than a coal mining town, it being free from coal dirt and also situated some little distance from the breaker.

The company has constructed a long concrete dam which forms a small lake, for the purpose of furnishing a water supply for the colliery boilers and for the town.

The following specifications cover the construction of the building, the heating arrangements and furniture not being included. As the exact cost of such a hospital will vary according to location, that is left out, but as a rough estimate it may be placed at from $10,000 to $15,000.

SPECIFICATIONS

These specifications are intended to embrace all work and materials necessary to complete the structure, ready for occupancy, except as may be herein specifically noted to be omitted.

The entire work shall be constructed and finished in every part, in a good substantial and workmanlike manner, according to the specifications, to the entire satisfaction of the architect and owner.

The plumbing, heating, and electrical work shall be omitted from this contract.

It is distinctly understood that the owner shall have the right to make such additions to, or deductions from, the labor or materials shown on plans or herein mentioned, that he may find necessary during the progress of the work, without in any way violating or vitiating the contract. The cost of such omissions or additions must be fully agreed upon, in writing, before the work is done or omitted, and the amount added to or deducted from the contract price.

Particular care must be taken of all finished work, during the progress of the building, such as stairs, glass, plaster, interior finish, etc., same to be protected in the best possible manner from injury, and replaced if damaged. Each trade must be responsible for and repair or replace, all damage to its own work, from whatever cause the damage may occur. Defacements of plastering and finished floors and all defacements must be made good.

The contractor is to assume all risk and bear all loss occasioned by neglect or accident during the progress of the work, until the same has been completed and accepted by the owner.

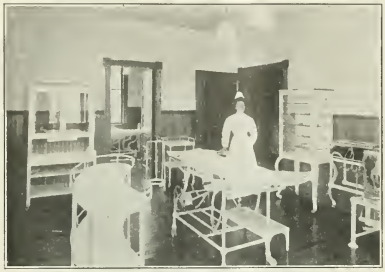


Fig. 3. Part of Operating Room

Fig. 4. Part of Operating Room

The general contractor shall keep the building insured to the full value of payment made thereon against fire until the final payment and acceptance.

If any of the several contractors shall fail to proceed with the work after——days' notice, his contract shall be declared forfeited.

The entire building and premises shall be thoroughly cleaned of all refuse. Same to be carted away at completion of the building, and at such times during its construction as the owner may request.

Excavate for the basement, wall trenches, piers, areas, etc., to depth shown on drawings; all of the earth shall be distributed and leveled off on the premises as the owner dictates. The top soil shall be laid aside where directed and afterward leveled off as directed by the owner. The contractor shall do all backfilling. The basement floor shall be leveled off and left clean of refuse.

The footing courses for inside walls and piers shall be of sizes shown on drawings and 12 inches thick, and shall be of concrete composed of one part American Portland cement, three parts clean, sharp sand, and five parts broken stone, with

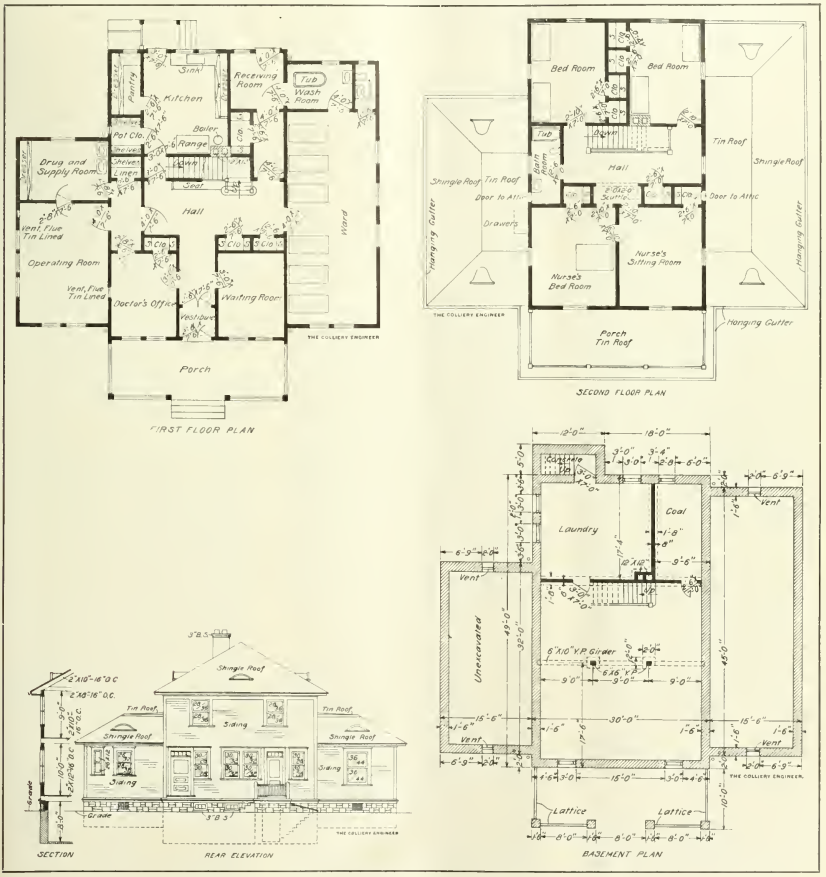


Fig. 5. Plans of Connell Colliery Hospital

sharp edges and egg size. The parts of the concrete shall be measured and thoroughly mixed dry. Concrete must be well tamped down in trenches, must be level and full width as indicated on drawings. Concrete footings for piers shall be curbed with rough boards to secure the true form and size of the piers as shown.

The foundation walls up to the underside of the first-story joists, shall be laid with good quality of quarry building stone, of good size and frequently bonded by large flat stones running clear through the wall. All stone work shall be laid with good Portland cement and clean, sharp sand, three to one. All stones to be well bedded and all joints and interstices filled with this mortar. The inside of walls shall be neatly laid and joints struck.

Lines of walls must be kept true and plumb and top leveled off to receive the wall plaster. Leave openings for sewers and other piping and tightly close with cement when pipes are in place.

Furnish and set all cut sandstone sills 3 inches thick for cellar windows and 3-inch sandstone cap, in one piece, for chimney.

All chimneys, wall forming laundry and coal bunker, etc., to be of good hard-burned, common brick, well laid with close joints, thoroughly slushed, using Portland cement mortar.

All flues, etc., shall be made true and plumb, the joints being pointed.

All flues to be terra cotta lined, with elbow inlets. All exposed brick shall be laid with pure white mortar, and the bricks wet in dry weather before being laid.

The wall around flues shall not be less than 4 inches thick. Each flue to be 12″ × 12″ terra cotta. Special care should be taken with all flues and none but the best mechanics shall be allowed to carry up the flues.

The entire cellar floor, except where marked "unexcavated," shall be leveled and tamped and shall be covered with good cement concrete 4 inches thick, and this with a layer (1 inch) of Saylor's Portland cement, smoothed off, graded, and leveled with rods and left in good condition at completion of the building. Outside cellar steps and area to be concrete.

Provide square iron lattice grilles for ventilating openings in basement walls.

All rooms, closets, and halls, of the first and second stories, to be lathed and plastered with good coats of mortar composed of best quality of lime, fresh hair, and clean, sharp sand.

All surfaces and angles to be made true and straight. The last coat to be a white coat. Plaster one coat back of all wainscot, dressers, wardrobes, and panel backs. The mortar shall season 10 days before being used.

Do all patching after other mechanics are finished and leave the work clean and in perfect condition.

The best quality of lath shall be put on in the best manner to form perfect clinch for plaster. Where the expansion of lath causes the plaster to break or buckle, the work shall be removed and replastered.

Wainscot the operating room, drug and supply rooms, kitchen, wash room, toilet and bath room of second story to a height of 4 feet 6 inches with simple rounded cap and plain base of Keene's cement put on in most approved manner with Portland cement backing, on expanded wire lath, to be full, true and plumb.

The mason must do all cutting in his trade for the other trades, and patch his work after they are finished.

All of the lumber used in the construction of this building shall be of sound, seasoned stock, free from shakes, flaws, and other defects and shall be framed in a substantial and workmanlike manner. Tail beams shall be framed into headers. All headers and trimmers shall be double the thickness of the floor beams. All partition bearing beams shall be tripled. All studdings at openings and heads of openings shall be doubled. No floor beams shall be placed nearer than 5 inches to any flue.

Truss over all wide openings, and frame for all stair walls, heater pipes, etc. The lumber used in the framing shall be of the following sizes:

First-floor beams, 2 in. × 12 in.; spaced 16-inch centers, of hemlock; second-floor beams, 2 in. × 10 in.; spaced 16-inch centers, of hemlock; attic-floor beams, 2 in. × 8 in., 16-inch centers of hemlock; rafters, 2 in. × 10 in., spaced 16 inches on centers, of hemlock; veranda-floor beams, 2 in. × 8 in., 12-inch centers, of hemlock; veranda-ceiling beams, 2 in. × 8 in., 12-inch centers, of hemlock; wall studding, 2 in. × 4 in., spaced 16-inch centers, of hemlock; studding of partitions, 2 in. × 4 in., 16-inch centers, of hemlock; girders, 6 in. × 10 in., of yellow pine; posts, 6 in. × 6 in., yellow pine; cross-bridging, 2 in. × 3 in., of hemlock.

All floor beams and studding and ceiling beams shall be firmly cross-bridged once in each section with 2″ × 3″ bridging. Floor beams and studding must be level and true to insure good lines in the plaster work. If not done so, the wall and ceilings must be made true with furring strips.

The partitions shall be stiffened with 2″ × 4″ horizontal cross-bridging, well nailed in. The rafters shall be stiffened with ceiling beams and collar beams, and the entire framework made rigid and secure. Do all cutting for other trades. Also all framing for heating pipes, registers, plumbing, etc.

All headers over 4 feet long shall be hung in wrought-iron bridles.

The walls and roofs shall be sheathed with ⅞-inch hemlock boards, well nailed to the studding and rafters. The wall sheathing shall be laid diagonally.

The floor beams of the first and second stories shall be covered with a floor lining of ⅞-inch hemlock stock boards, laid diagonally and nailed to the beams. Leave openings for piping and cover same properly so that they may be easily reached.

The finished floors for the entire first and second stories to be ⅞″ × 2½″ matched, kiln-dried No. 1 white maple, laid perfectly smooth and finished with three coats of varnish, rubbed to a dead finish.

All the exterior woodwork shall be of clear white pine. The floors of the verandas shall be of 1⅛-inch thick and 2½-inch wide, and matched, clear white pine.

The ceilings and verandas shall be ⅞″ × 2½″ beaded whitewood and molded at angle of ceiling and girded with facias.

The soffits of cornices and overhangs shall be ceiled up with narrow matched and beaded ⅞-inch white pine ceiling boards.

Screens shown underneath porches at front shall be of square latticed type.

The siding shall be narrow, good quality white pine, laid 4 inches to the weather.

The porch railings shall be made of 2″ × 4″ clear white pine with rounded corners. Balusters to be made of 1¼″ × 1¼″ clear white pine, 2½ inches on centers.

The basement window frames shall be of 2-inch plank with rebate molding for screens and sash and outside joint molded. Such as may be shown shall have box frames. All window frames shall have boxes for weights and shall have 2-inch head and sills, 1⅛-inch pulley stiles, fitted with large loose axle pulleys, ⅞-inch back and front lining, all to be of clear white pine, kiln dried. All frames to be primed before leaving the mill. The sash shall be 1½-inch thick in all windows.

Where heater pipes require extra width, the carpenter shall fur out side of room to cover them. Put on grounds for all openings, base and wainscot; all grounds to be of white pine, and strip the ceiling if the beams are not level and true.

The sheathing of all walls and overhangs shall be covered with one-ply layer of sheathing quilt roofing, as may be approved by the owner.

Slope roofs shall be covered with best quality sawed white pine shingles, laid 4 inches to the weather.

Valleys, deck roofs, gutters, and flashings shall be of Taylor's Old Style or Muerer Bros. American IX tin. The valleys shall run well up under the wall coverings or roof shingles; all joints shall be well soldered and made perfectly tight.

Do all flashing, step-flashing, and counter-flashing on chimneys, walls, roofs, window heads, and molded courses, etc., necessary to make all parts of the roofs water-tight.

All roofs shall have hanging gutters of heavy galvanized iron, properly supported by gutter brackets, graded to outlets, with connections for roof water pipes, of 4-inch diameter, corrugated galvanized iron leaders for main roof, and 3-inch diameter leaders for porches, run to grade and connected with plumber's pipes.

All gutters shall be well made and have galvanized malleable iron hold-fasts to wall every 6 feet in length.

The roof ridges shall be neatly made, fitted and set of clear white pine.

The cellar windows shall be glazed with single-thick glass. All other windows shall be glazed with best quality double-thick glass.

All rooms, halls, closets, etc., throughout the first and second stories, not otherwise specified, shall be finished with the best quality of yellow pine.

All interior trim to be kept very simple.

The window and door casings are to be ⅞ in. × 5 in. plain with rounded edge. The baseboard is to be ⅞ in. × 6 in., chamfered edge, with quarter round to cover joint at floor.

All trim shall be of full length pieces, and base shall be in full lengths from wall to wall or opening.

Furnish and erect neat molded pipe boards for plumber and panel all recesses for piping.

The treads and risers of the principal staircase from first to second stories, shall be of good yellow pine. The treads shall be 1⅛ inches thick, risers ⅞-inch thick, housed, glued and wedged, with molded nosing. The railings shall be of simple, square balusters, three to a tread, with 3″ × 2½″ molded hand rail, and 5-inch plain molded newel posts. The railings, balusters, and newels shall be of yellow pine. The wall strings shall be of ⅞-inch thick molded, eased at changes of pitch and made to fit neatly.

The serving pantry shall be fitted with shelves above and drawers and cupboards below main shelf, those below to have paneled doors, and those above to have glazed doors.

Shelves shall be neatly and securely fitted in position. All cupboards shall be hung in the best manner. All woodwork of serving pantry shall be of yellow pine and made as per directions.

The dressers for drug room and kitchen are to be made as above.

Construct cellar stairs of good hemlock, 1⅛-inch treads, no risers, plain hand rail, square newels, plain.

Provide linen closet with six shelves, made as per instructions. All closets shall be fitted with shelves, and with clothes rail and hooks, as shall be directed. All the above work to be of yellow pine.

Provide medicine closet with adjustable shelves.

Provide scuttle to get from second story to ventilating space.

Provide ample seat for hall, 1¾ inches thick, solid ends.

The front and vestibule doors and doors leading to upper porch to be as per detail drawings. All other doors throughout the building to be simple 1¾-inch thick stock doors, clear white pine, of design as selected by the owner. [Note.—Plain varnished steel doors and casings are used in some hospitals.—Editor]

Provide double-thick batten doors for cellar entrance, also plain doors to ventilating space under roofs.

Before being finished or painted, the interior woodwork shall be sandpapered and made perfectly smooth and even. All moldings, etc., shall be well cleaned.

The materials used in the finishing and painting to be of the best of their several kinds. Use pure linseed oil and white lead for all painted work. Pure turpentine, best shellac, and grain alcohol, Wheeler

or equally good filler, and Berry Bros., Murphy's Keystone, or other approved varnish will be used as directed and required to get the best results for the different degrees and kinds of finish required.

The yellow pine shall be well filled and finished with one coat of filler and three coats of varnish, rubbing down after first coat and last coat, and leaving the work with smooth finish. The finish and rubbing of the yellow pine must be done to the architect's satisfaction.

All shingles of walls and roofs shall have two coats of Cabot's Creosote stain of such colors as shall be directed. Shingles shall be dipped once before being put on. This shall count as one coat.

The Georgia pine in kitchen and pantry shall have three coats of Crockett's Preservative, or varnished, as required. All floors throughout the house to be finished with three coats of varnish, rubbed to a dead smooth finish.

Paint all exterior woodwork and metal with three good coats of oil and lead paint, of colors directed by the owner. Putty all nail holes, joints, etc., and kill knots.

If the owner so desires, the contractor is to stain any part of the exterior or interior trim, in colors as selected, and to be applied in the most approved manner. (Three-coat work.)

Supply and install square lattice registers for vent flues from operating room. Flues to be tin lined, height of first story.

The contractor shall allow the sum of $60 for all door and window hardware for the building. The owner shall purchase the hardware for the above sum, but the contractor shall pay for and fit it in the best manner. This sum shall not include the cost of sash weights, sash chains, cords, or pulleys, or hangers for sliding doors or hinges or fasteners for basement windows, all of which material the contractor must purchase and apply.

The contractors must do all cutting in their trades for the other trades.

Fan Tests

Mr. John Watson, in a paper on "The Testing of Fans," read before the Mining Institute of Scotland, April, 1913, said:

Fan tests that are presumably conducted and published in good faith vary so widely in their results, particularly in regard to efficiency values, that it would be well if the conditions under which fans are to be tested were standardized. The value of the results, as a guide to the selection of a fan to work under given conditions, and to advance in fan design and construction, would therefore be considerably enhanced if the conditions of testing were known to be reliable. The objects of fan testing are, generally, to determine (*a*) the quantity of air per minute passed by the fan, (*b*) the resistance overcome by the fan, namely, the water gauge, (*c*) the efficiency of the fan, and, in some cases, (*d*) the efficiency of the whole plant. In evidence of the divergence of practice in regard to measurement of the air and the water gauge, the following stipulations are extracted from recent fan specifications, not with the view of criticizing the stipulations themselves, but solely for the purpose of exhibiting the differences of opinion existing: (1) The quantity of air and the water gauge are to be measured in the upcast shaft. (2) The quantity of air and the water gauge are to be measured at the pit bottom near the separation doors. (3) The quantity of air is to be measured in the fan drift at a place specified, and the water gauge is to be measured by a tube led into a box in the side of the fan drift covered by a perforated plate. (4) The quantity of air, the speeds, the horsepower in the air, and the brake-horsepower at the fan pulley with varying water gauges of 3, 4, 5, and 6 inches by constant equivalent orifice, must be stated. When conditions differing so much are laid down, and where such differences in actual practice in testing as have been referred to are possible, one need hardly wonder that the results of tests are not readily comparable. The writer submits, therefore, that the whole subject of fan testing requires careful consideration, in order that conditions universally applicable may be devised, so that the results of tests which may be carried out under these conditions would be readily comparable.

Itinerary of Bureau of Mines Rescue Cars

The United States Bureau of Mines announces that Pittsburg car No. 6 will be stationed at the special siding at Fairmont, W. Va., until December 30, to serve the following companies in that vicinity.

Consolidation Coal and Coke Co.; Jamison Coal and Coke Co.; Hutchinson Coal and Coke Co.; New Central Coal and Coke Co.; Maderra-Hill-Clark Coal and Coke Co.; Virginia and Pittsburg Coal and Coke Co.; Federal Coal and Coke Co.; Four State Coal and Coke Co.; Winchester and Virginia Coal and Coke Co., and Elkins Coal and Coke Co.

The Wilkes-Barre car No. 1 will be at Olyphant, Pa., December 1 to 17; from December 18 to January 23, 1914, at Dunmore, Pa., and from January 24, until March 6, at Providence, Pa.

The Evansville car No. 3 will be at Linton, Ind., November 3 to 17, for the benefit of the Vandalia Coal and the United Fourth Vein companies. November 17 to 29 the car will be stationed at Bicknell, Ind., where it will accommodate the Tecumseh Coal and Mining Co., Bicknell Coal Co., Freeman Coal Co., and the Linn Coal Co.

Car No. 7 will be at Gary, Elbert, and Anawalt, W. Va., from October 27 to November 8, for the United States Coal and Coke Co.; from November 10 to 29 at Pocahontas, Va., Jenkin Jones and Switchback, W. Va., for the Pocahontas Consolidated Collieries Co. During the month of December, the car will make 1-week stays at Olmstead, Vivian, Eckman, and Powhattan, W. Va., for the companies operating in the neighborhood of those towns.

First Aid to The Injured

Reports of Contests and Competitions Held by the Teams of the Different Companies and Organizations

American Mine Safety Association

First-Aid and Rescue Contest—Bruceton Explosion—Teams that Received Prizes

By W. Z. Price

THE American Mine Safety Association met in Pittsburg, September 22-24, and held a most successful field day and experimental mine explosion.

The mine rescue and first-aid contest took place in Arsenal Park and despite the raw weather, sometimes a drizzling rain, there were several thousand spectators present. The new rescue car, Fig. 2, of the United States Bureau of Mines, was on the ground with its crew and it attracted a great deal of attention.

In the mine rescue contest, each crew consisted of five men, one of whom acted as captain. Each man was provided with a breathing apparatus, and safety and electric lamps.

After the men had donned the apparatus, their movements were guided by the captain, who signaled them with a horn.

Surgeons noted the pulse and respiration of each man before allowing him to put on the apparatus, which was first tested by the wearer.

The captains inspected the apparatus of their men, noting the number of each apparatus worn and the reading of the oxygen gauge. One of the team then inspected the apparatus worn by the captain.

When an event was called, the team listed for that event appeared before the judges, who inspected the equipment and made a discount for any improper connection or adjustment of the apparatus, lamp, or accouterment. The team then ran at a trot about 100 yards, and entered an air-tight cage, made of wood and glass, containing formaldehyde fumes, and remained there about 10

Fig. 1. The Colliery Engineer Challenge Cup

minutes. On emerging from the cage, the pulse and respiration of each man was again ascertained. Penalties were inflicted if the members of the crew became separated by more than 6 feet during recovery work. They were penalized if they failed to stop at intervals of 300 feet and rest for 1 minute, also if they failed to comply with the captain's signal or did not have a full charge of oxygen and a fresh charge of potassium hydrate when the apparatus was put on.

A fire boss stationed at the mine entrance examined the safety lamps carried by the rescue crew.

The teams entered were, Ellsworth Collieries Co.; H. C. Frick Coke Co.; Jamison Coal and Coke Co.; Pittsburg-Buffalo Coal Co.; Pittsburg Coal Co.

The judges were G. H. Hawes, Duluth, Minn., chairman; Oscar Cartlidge, manager of Mine Rescue Station, Springfield, Ill.; Dr. J. M. Booker, United States Bureau of Mines, Pittsburg, Pa.; H. L. Owens, Lehigh and Wilkes-Barre Coal Co., Wilkes-Barre, Pa.

FIRST-AID CONTEST

The following companies with thirty teams were represented in the contest: Allegheny Coal Co., Allegheny River Mining Co., Cambria Steel Co., Consolidation Coal and Coke Co., Ellsworth Collieries Co., Jamison Coal and Coke Co., Manor Gas and Coal Co., New Alexander Coal Co., Oliver and Snyder Steel Co., Pennsylvania Coal and Coke Co., Penn Gas Coal Co., Penn Mary Coal Co., Pittsburg-Baltimore Coal and Coke Co., Puritan Coal and Coke Co., Republic Iron and Steel Co., Rochester and Pittsburg Coal and Iron Co., Tower Hill Connellsville Coal and Coke Co., Tunnel Coaling Co., Vinton Colliery Co., Watkins Coal and Coke Co., Westmoreland Coal and Coke Co., Youghiogheny and Ohio Coal Co., Vandalia Coal Co.

Each team was composed of five men and a captain. The triangular bandage was the standard of the contest, but if a team used roller bandages properly, they were given equal credit.

The judges performed their work progressively. Time was not an element unless the team or men performing ran over the allotted time or failed to give treatment properly. All events began and ended at the sound of the horn.

The judges in the first-aid contest were: Major R. U. Patterson, American National Red Cross, Washington, D. C., chairman; Dr. F. U. Ferguson, Gallitzin, Pa.; Dr. Edward Pardoe, South Fork, Pa.; Dr. G. H. Halberstadt, P. & R. Coal and Iron Co., Pottsville, Pa.; Dr. W. S. Rountree, Tennessee Coal, Iron and Railway Co., Birmingham, Ala.; Dr. J. W. Keinham, Pittsburg Coal Co., Pittsburg, Pa.; Dr. D. E. Sable, Chief Surgeon, Department of Public Safety, Pittsburg, Pa.

At 8 o'clock that evening, Chairman H. M. Wilson, of the American Mine Safety Association, called the first meeting of the Association to order in the Fort Pitt Hotel, and introduced the speakers of the evening.

Assistant City Solicitor, H. M. Irons, welcomed the assemblage to Pittsburg in the name of the city and the mayor, W. A. Magee.

James I. Parker, chief clerk of the Department of the Interior, who spoke on behalf of Secretary of the Department of Labor, William B. Wilson, who was detained in Washington, explained that the Department of the Interior is deeply concerned in the "baby bureau" of the department, because it was the last established, and is a bureau in which the department heads take great interest. He said, in conclusion, "I don't think the Government can spend too much money on the work of conserving human life."

Van H. Manning, assistant to the Director of the Bureau of Mines, said that steps are being taken to have federal, state, and private individuals cooperate in efforts to lessen the loss of life in mines; not only coal mines, but metal mines and quarries. He explained that no other government in the world has anything like the experimental mine at Bruceton, Pa., where tests are made under the actual conditions which exist in a mine.

John P. Reese, vice-president of the American Mine Safety Association, said: "This is a work in which every interest concerned with mining can get together, from the operator to the laborer and do good work, and I know the miners themselves are interested."

Chairman Wilson then announced the following prize winners:

MINE RESCUE CONTEST

First Prize. The Colliery Engineer Challenge Cup. One silver cup to be known as "The Colliery Engineer Cup," donated by The Colliery Engineer. This cup was presented to the team scoring the highest number of points in all events and will remain in the possession of this team until the date of the next annual meeting, when it will be contested for again. Any team winning this cup two consecutive times will become the sole owner. Five bronze medals, donated by the American Mine Safety Association, for the highest percentage, were included with the cup in the first prize, which was won by the Pittsburg Coal Co. team with a rating of 95 per cent.

Second Prize. Five "Ceag" electric hand lamps and chandelier, donated by the Mannesmann Light Co., to the members of the team scoring the second highest percentage, were awarded to the team of the Pittsburg-Buffalo Coal Co., who received a mark of 93 per cent.

Third Prize. One Draeger Oxygen Inhaler, donated by the Draeger Oxygen Apparatus Co., was captured by the H. C. Frick Coke Co. team, with an average of 85 per cent.

Fourth Prize. One Hirsch Electric Mine Cap Lamp, donated by the Hirsch Electric Mine Lamp Co., was given to the captain of the team scoring the fourth highest percentage; also, $12 was donated by the American Mine Safety Association, for equal division among the remaining four members of the team. This prize was won by the Jamison Coal and Coke Co. team, with 83 per cent.

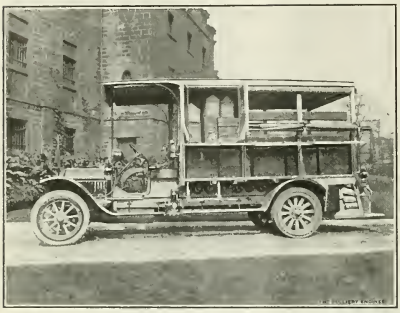


Fig. 2. Automobile Rescue Truck, U. S. Bureau of Mines

Fig. 3. Vandalia Coal Co.'s Rescue Team

Fifth Prize. Ten Dollars, donated by the Mannesmann Light Co., for equal division among the team scoring the fifth highest percentage. The Ellsworth Collieries Co. team won this prize, with a mark of 75 per cent.

FIRST-AID CONTEST

First Prize. As a first prize in the first-aid contest, The Colliery Engineer donated to the Association a challenge cup, to be known as "The Colliery Engineer Cup," which will remain the property of the winning team until the next annual meeting, when it will be contested for again. The team winning this cup two consecutive times will become the owner. This cup, shown in Fig. 1, was given to the team scoring the highest number of points in all five events of the contest, as well as six silver medals, donated by the Association.

The Penn Mary Coal Co. team of Heilwood, Pa., won this prize, with a rating of 100 per cent., and in addition, the special prize of six bronze medals donated by the American Red Cross, and the special grand resuscitation prize, one silver cup, to be known as the "Westphalia Cup," donated by S. F. Hayward & Co., American agents for the "Westphalia" mine rescue and oxygen reviving apparatus. This cup is presented to the team excelling in the methods of resuscitation, and will remain in possession of that team until the date of the next annual meeting, when it will be contested for again. The cup will become the property of the team winning it two consecutive times.

Second Prize. Eighteen Dollars, donated by Mannesmann Light Co., and the special grand prize of six bronze medals, donated by the American Mine Safety Association, was won by the Penn Gas Coal Co. team, with 97⅖ per cent. mark.

Third Prize. Twelve Dollars, donated by the Mannesmann Light Co., was won by the Cambria Steel Co. team, who received a mark of 97⅕ per cent.

Fourth Prize. First-Aid Cabinet, donated by Johnson & Johnson, was won by the Jamison Coal and Coke Co. team, which was given a rating of 97 per cent.

Fifth Prize. First-Aid Cabinet, donated by Bauer & Black, was won by another Penn Gas Coal Co. team, with a 96½ per cent. mark.

Sixth Prize. First-Aid Instruction Outfit, donated by Johnson & Johnson, was won by the Oliver & Snyder Iron and Steel Co. team, with a percentage mark of 95½. This team also won a special grand prize, consisting of a silver cup, donated by *The Coal Trade Bulletin* to the team making the best appearance in efficiency, training, and drill, regardless of points scored.

Seventh Prize. A stretcher, donated by Frick & Lindsay, was won by Consolidation Coal Co. team, with 94⅘ points.

Eighth Prize. One Tabloid First-Aid Box, donated by Burroughs, Wellcome & Co., was won by another Jamison Coal and Coke Co. team, with 94⅗ per cent. rating.

Ninth Prize. One year's subscription to *The Coal and Coke Operator and Fuel Magazine,* donated by the Coal Publishing Co., was won by Westmoreland Coal and Coke Co. team, with a mark of 94⅗ per cent.

Tenth Prize. Six months' subscription to *The Coal and Coke Operator and Fuel Magazine,* donated by the Coal Publishing Co., was won by the Vandalia Coal Co. team, of Linton, Ind., with 94⅕ per cent.

Eleventh Prize. Five Dollars, donated by the *Coal Age,* was won by the Tunnel Coaling Co. team, which received a mark of 94 per cent.

Fig. 4. Penn-Mary Team. Winners of the Colliery Engineer Cup

On Tuesday morning, September 23, the opening session of the Association was held, and a constitution adopted, which was later amended to allow metal mining men to become members of the Association. It was also decided to hold the annual meetings of the Association not later in the year than September.

In the afternoon, the members went to the Bruceton mine, of the United States Bureau of Mines, where an artificial mine explosion was to be staged. About 300 spectators were gathered in the vicinity of the mine when the explosion occurred.

The proposition was to test the influence on a coal-dust explosion, of a Taffanel stone dust barrier, which consisted of 10 shelves, 2 feet wide, 6 feet from center to center, placed across the entry, 500 feet from the mouth of the mine, and 800 feet from the face where the explo-

sion was to originate. These shelves were loaded as heavily as possible with stone dust.

When the igniting shots started the explosion, there was a terrific roar, and the black smoke shot out of the mine mouth about 500 feet across the ravine, but no flame was noticed, due probably to the stone dust, yet the concussion was tremendous.

On Wednesday morning, September 24, the final meeting was held, at which Chairman H. M. Wilson was elected the first president, to serve until January 1, 1914, after which the following officers will serve for one year:

President, John P. Reese, Gillespie, Ill.; first vice-president, Dr. A. F. Knoefel, Linton, Ind.; second vice-president, Joseph Fletcher, Frontenac, Kans.; third vice-president, Pearson Wells, Ironwood, Mich.; Executive Committee: Dr. W. S. Rountree, Birmingham, Ala.; E. H. Weitzel, Pueblo, Colo.; Col. R. A. Phillips, Scranton, Pa.; Dr. G. H. Halberstadt, Pottsville, Pa.; Prof. F. W. Sperr, Houghton, Mich.; W. H. Aldridge, New York, N. Y.

Resolutions were passed, thanking H. M. Wilson for his painstaking efforts in bringing about a successful organization. A vote of thanks was extended to Dr. J. A. Holmes for the cooperation of the United States Bureau of Mines and also to the teams and companies represented at the Field Day.

Vandalia Coal Company

On September 13, six first-aid teams of the Vandalia Coal Co., Linton, Ind., competed in the skating rink of that town, for a prize trip to the American Mine Safety Association meeting at Pittsburg, September 22-24. In this competition the rescue teams were compelled to carry men on stretchers over obstructions placed in an artificial entry, which is a difficult task for men even when not equipped with helmets, especially if the man is large.

The first-aid corps in this competition, solved several difficult problems, the Vandalia No. 9 team being the winner. This team, Fig. 3, which afterward went to the contest at Pittsburg, is composed of Charles

Fig. 5. Trapper Boys' First-Aid Team

Dodge, captain, John Brown, John Parks, Thomas Parks, and David Beaty.

The judges were Dr. John Talbott and Luther Floyd, the latter being in charge of the United States Bureau of Mines car No. 3. All the contestants were members of the Vandalia First-Aid and Mine Rescue Auxiliary, of which Dr. A. F. Knoeful is the instructor.

Fig. 6. Members of Trapper Boys' Team

The Vandalia Coal Co. is said to be the pioneer of the Middle West in first-aid work, having established this movement in 1910, and this makes the third annual contest between company teams.

Luther Floyd, in charge of Mine Rescue Car No. 3, was sent to Vandalia by the Bureau of Mines, to give the miners training in the use of helmet apparatus. Mr. Floyd has been quite successful in instructing men along this line and from accounts is an expert in helmet training.

Stearns Coal & Lumber Co.

On July 4, the first-aid teams of the Stearns Coal and Lumber Co. gave an exhibition of their work at Stearns. The prizes offered were $30 in cash as first prize and six carbide lanterns as second prize.

A team from Yamacraw and one from Stearns tied for first place. The trapper boys, who exhibited at the Lexington meet in May are shown in Fig. 5 dressed in their mine clothes and with their faces blackened. The same team is shown in their July 4 clothes in Fig. 6, when they won second prize at Stearns.

H. C. Frick Coke Co.

During the week of September 22, 61 first-aid teams of the H. C. Frick Coke Co., contested for supremacy at eight of the company's operations.

The winning teams and the plants where the contests took place are as follows:

At Standard, the Southwestern No. 2 team, with a mark of 100 per cent.

At United, the United team with 99¼ per cent.

At Continental No. 1, Phillips team, 98¼ per cent.

At Kyle, Redstone team, with 97.8 per cent.

At Trotter, Coalbrook team, with 97¾ per cent.

At Footdale, Lambert team, with 97 per cent.

At Filbert, Colonial No. 1 team, 94½ per cent.

At Whitney, Whitney team, 92½ per cent.

The various contests were conducted under the supervision of Chief Mine Inspector Austin King, C. L. Albright, manager of the voluntary accident relief department, Mine Inspectors Stephen Arkwright, J. E. Struble, and P. S. King.

Red Cross Muckle Cup Contest

The fifth annual competition for the cup presented by Mrs. John S. Muckle, President of the Red Cross Society of Pennsylvania, took place September 27, at Inkerman, near Wilkes-Barre. This contest is open to all first-aid teams in the anthracite regions, and since it is a seminational affair, all companies should have been represented. The companies who sent representatives were:

Delaware, Lackawanna & Western Coal Co., which entered Bellevue, Sloan, Brisbin, Storrs, and Nanticoke collieries; 5 teams.

Sterrick Creek Coal Co.

Scranton Coal Co., Pine Brook team, Scranton.

Jermyn Coal Co., Rendham.

Temple Iron Co., Forty Fort, Mt. Lookout, Wyoming, and Lackawanna, Olyphant; 3 teams.

Northwest Coal Co., Simpson.

Pennsylvania-Hillside companies, Erie, Mayfield; No. 2 shaft, No. 1 colliery, Dunmore; No. 5 shaft, No. 6 colliery, Pittston; Old Forge breaker, Old Forge; Law shaft, Avoca; Fernwood slope, Butler colliery, Pittston; 6 teams.

Heretofore United States army officers have been judges at these contests, but owing to varying circumstances and to death in the family of Major Lynch, civilian surgeons were substituted. They were Drs. W. S. Fulton, Scranton, John W. Grant, Carbondale, J. A. Singer, East Stroudsburg. Dr. F. F. Arndt directed the affair, and was assisted by F. D. Conover and J. S. Angler, as secretaries, and Edgar Weichel, timer.

The problems worked by the teams were devised by United States Army surgeons, and sent on from Washington, D. C., in sealed envelopes, and opened on the field.

The Muckle Cup is to be won three times before it becomes the property of any team, which practically brings the honor down to holding it once. The winners to date follow:

1909, Law shaft, Avoca, Pennsylvania Coal Co.

1910, Woodward colliery, D., L. & W. Coal Co.

1911, Brisbin colliery, D., L. & W. Coal Co.

1912, Pine Brook colliery, Scranton Coal Co.

1913, Old Forge breaker, Pennsylvania Coal Co.

The members of the Old Forge team were Moses Ballentine, captain, Michael Quinn, Thomas Cranston, Henry McGerrity, William Sibley. William Bennett, subject.

The teams finished in the following order: Old Forge, 98⅖; Fernwood, 97⅗; Bliss, Nanticoke, 97⅖; Forty Fort, 97⅖; Erie, 97⅕; Sterrick Creek, 96⅘; No. 5 shaft, No. 6 colliery, 96⅕; Pine Brook, 96⅖; Law shaft, 96⅕; Lackawanna, 95⅗; No. 2 shaft, No. 1 colliery, 95⅖; Storrs, 95⅕; Bellevue, 94⅕; Sloan, 94⅗; Mt. Lookout, 94⅖; Brisbin, 93⅗; Jermyn, 93⅕; Northwest, 88⅕. More teams were entered in the contests this year than ever before, and it is urged that all anthracite companies send teams to these events each year.

Fig. 7. Old Forge Team Sitting. Judges and Officials Standing

Fig. 8. Bellevue Team, D. L. & W. Coal Co.

It will be noticed that there was a difference of just 5 points between the 17 leading teams, that the problems were known to the teams as soon as to Doctor Arndt, and further that the teams who won their intracompany events were unable to win in this intercompany contest. This is not unusual and is not more due to the preference of judges as to the way to dress injuries, than to the fact that one team is more apt in certain lines than in others. In 1912, the Pine Brook team won the Muckle Cup, beating the Price-Pancoast team. One week later in an intracompany contest the Price-Pancoast team won from the Pine Brook team. In 1913 the Brisbin team won two cups in the intracompany contest, and in the Muckle cup contest was beaten by four teams it had previously conquered. There were three judges and each were allotted two teams whom they watched with an eagle eye, thus each judge had six teams that worked on the

same problem but not all at the same time. In the next event the judges would not watch the same teams they did in the previous event.

This method of procedure eliminated the personal equation so far as the judges were concerned.

Knoxville First-Aid Meet

Much interest was manifested North and South in the Miners' First-Aid Field Day, held in conjunction with the National Conservation Exposition, at Knoxville, Tenn., September 20, 1913. The idea of holding this field day during the exposition originated with E. F. Buffat, President of the Piedmont Coal and Coke Co., of Oliver Springs, Tenn. It was due to the efforts of Messrs. Buffat, M. E. Sutton, J. R. Williams, J. E. McCoy, George M. Camp, and D. T. Blakey that the affair was so widely advertised, so elaborately planned and so successfully staged. The program included: Review of the teams, and an address of welcome by Hon. T. A. Wright, President of the Exposition, who said something about as follows: "The early Greeks and Romans had contests in which athletes strived to maim and kill each other; in our day we have contests to ascertain who is the most expert in treating injuries and in saving life."

The prizes were exceptionally valuable and all the teams received some memento of the event. The judges appointed by Mayor Patterson, of the American Red Cross, were Lieutenant E. R. Hostetter, U. S. A.; H. Q. Fletcher, U. S. A.; Lieutenant W. T. Davis, American Red Cross; Dr. William Bowen, Dr. Cary A. Snoddy, Dr. C. M. Drake, Major J. H. McCall, T. N. G., and R. S. Kirby-Smith, U. S. A.

Twenty-one teams took part in the contests.

The Briceville team, of the Tennessee Coal Co., won the first grand prize, which consisted of a silver cup, $25 cash, six gold medals and five bronze medals.

The team members were Harry R. Smith, captain, Greely Oaks, Fred Kreis, Thomas Brown, Robert Shinliver, Conley Maiden. Rating, 95⅗. This team also won the Tennessee cup prize presented by Southern Appalachian Coal Operators' Association.

The Westbourne Coal Co. team, of Westbourne, Tenn., received a mark of 95, thereby annexing the second grand prize, a Draeger

E. F. Buffat, Chairman of Field Committee

breathing apparatus, $25 in cash, six silver medals, and Red Cross certificates. This team also won the second Tennessee prize, $25, presented by A. S. Cameron Steam Pump Co., of New York. The members of this team are Richard Rigsby, captain, John Galbreath, Harvey Duncan, Joseph Capps, Thomas Day, and Charles Seiber.

The third grand prize was captured by the Jellico Coal Co. team, of Mountain Ash, Ky., with a mark of 93⅖. The prize was an ambulance hamper, given by Seibe-Gorman Co., of Chicago, $10 in cash given by the Pennsylvania Crusher Co., of Philadelphia; six bronze medals and Red Cross certificates. In this corps were Samuel Marsh, Jr., captain, Edward Righby, Titus Barwick, Harry White, Walter Nunn, and W. K. Parrott.

The International Textbook Co. donated to the team making the highest average in team events, one Complete Coal Mining Course in the International Correspondence Schools; two years' subscription to The Colliery Engineer, and the Coal and Metal Miners' Pocket Book. The Roane Iron Co., Knoxville Iron Co., and the Piedmont Coal Co. teams tied for this prize, with a mark of 94½.

The names of those comprising the teams follow: Roane Iron Co., No. 1, Rockwood, Tenn., W. M. Mills, captain, J. A. Rodgers, O. D. Fleming, W. C. Mahady, F. C. Baird, J. A. Phillips. Mark, 94½.

Knoxville Iron Co., Briceville, Tenn., John M. Wood, captain, Isaac Phillips, Samuel Stonecipher, J. R. Henson, L. A. Shoemaker, W. L. Underwood. Mark, 94½.

The Piedmont Coal Co., Oliver Springs, Tenn., George Vinsant, captain, Theodore Smith, John Medaris, Samuel Gonns, Andrew Wilson, Clyde Boy. Mark, 94½.

To the team making the second highest score, the International Textbook Co., donated a Short Coal Mining Course in the International Correspondence Schools; one year's subscription to The Colliery Engineer and a copy of the Coal and Metal Miners' Pocket Book. These prizes the Tennessee Copper Co. team, of Ducktown, Tenn., obtained with a mark of 94. The roster of the team was Edward Roberts, captain, Mark Anderson, Milton Lovelace, Charles Allen, Ralph Gibson, John Fraley.

The team making the third highest average was from the Stonega Coal and Coke Co., Big Stone Gap, Ky. Mark, 92. The prize was $15 and six steel tapes from the Lufkin Rule Co., Saginaw, Mich., William Simpson, captain, L. C. Fraley, William Cook, Kelly Cook, John Fraley, A. P. Profit.

The first prize for the one-man event was a gold watch, given by Walsh & Weidner Boiler Co., Chattanooga, Tenn. A representative of the Coal Creek Coal Co., won this with a mark of 96. For the second prize the representatives of the

Standard Jellico Co., Clearfield, Tenn., the Stonega Coal and Coke Co., Imboden, Va., and the Continental Coal Corporation, Pineville, Ky., tied with a score of 95. The decision was given to the Stonega representative.

Wisconsin Steel Co. team No. 1, Benham, Ky., won third prize with a score of 94.

In the two-man event, representatives from Wisconsin Steel Co. No. 2 team, received 100; the Barker No. 2 Continental Coal Corporation, 94; and Wisconsin Steel Co.'s No. 3 team, 91. The first prize was $15, given by the Ohio Brass Co., Mansfield, Ohio. Second prize, $10, given by A. Leschen Sons Rope Co. Third prize, a first-aid cabinet, presented by Johnson & Johnson.

The Wisconsin Steel Co.'s No. 3 team and the Stearns Coal and Lumber Co. team, Stearns, Ky., tied in this event, the decision eventually going to Wisconsin Steel Co.

The winners of the three-man event were Black Diamond Coal Co., Coal Creek, Tenn., 95; Minersville Coal Co., Pless, Tenn., 91; and Roane Iron Co. No. 2 team, 84. The prizes were $10 from Ohio Brass Co., and $5 from Miners' Field Day Committee. Second prize, three thermos bottles from the Milwaukee Locomotive Works. Third prize, three flash lights. The silver cup presented by the Provident Life and Accident Co., of Chattanooga, belongs to the team who won the first grand prize.

Secretary of Labor, W. B. Wilson, before presenting the prizes, told how he had spent 37 years of his life in the coal mines, swinging the pick, which was one of the most dangerous occupations. He congratulated the teams on their efficiency and said they were all able to give aid when rescue work is needed and that was more important than all prizes.

Miss Mabel Boardman, of the Red Cross Society, said: "All the teams had won a greater prize than any man can give—the power to save human life." The rain commenced to pour down and drove participants to shelter. It is estimated that 5,000 people attended these exercises, which were continued during the evening by the Bureau of Mines.

The judges were Dr. Charles L. Shafer, of Kingston, and Dr. W. C. Lathrop, of Hazleton.

The system of scoring was the one adopted by the American Mine Safety Association.

The prizes striven for were: a trip to the meetings of the American Mining Congress in Philadelphia, in October, for the winning team in addition to the possession of the loving cup. The winner of the one-man event, Simon Fellin, was also entitled to accompany the team to Philadelphia.

The Derringer team won the cup, and its captain won the one-man event, and as the captains of the Westmoreland and Franklin teams tied for second place, they both will accompany the Derringer team to Philadelphia. Results were as follows:

Derringer No. 1, 97½ per cent. Simon Fellin, captain, Joseph Fellin, Henry Poncaire, Isaac Morgan, Leon Poncaire. Thomas Gibson, subject.

Franklin, 97⅜ per cent. John O'Neil, captain, Edgar Boston, William Morgan, Harry Thomas, Hugh Owen, subject.

Packer No. 5, 97⅛ per cent. John McLain, captain, Charles Calvert, Joseph Kerwin, Henry Carey, John Sheridan. Thomas Brown, subject.

Westmoreland, 96⅞ per cent. John R. Morris, captain, Edward Reap, Thomas Ridgeley, Walter Jacoby, Joseph Johnson. Fred Halpin, subject.

Primrose, 96⅜ per cent. Anthony Gludden, captain, Henry O'Donnell.

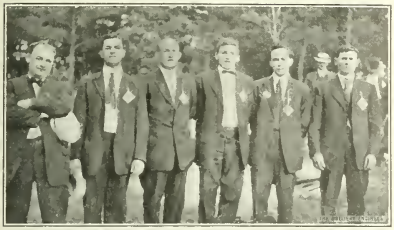


Fig. 9. Captains of Prize Teams, Lehigh Valley Coal Co.

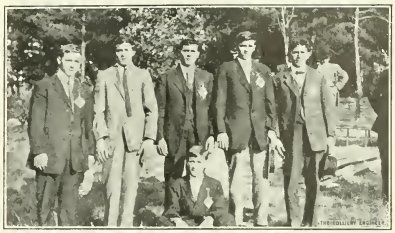


Fig. 10. Derringer Team, Lehigh Valley Coal Co.

Lehigh Valley Coal Co.

On Saturday, September 13, at Hazle Park, near Hazleton, Pa., the Lehigh Valley Coal Co., held their final first-aid contests of the year. Previous to this date the 76 first-aid teams of the company, divided among the six divisions, held preliminary meets in which the prize team of each division was selected in order to compete for the loving cup.

The representative teams at the contest were Westmoreland of the Lackawanna division, Franklin of the Wyoming division, Derringer No. 1 of the Coxe-Lehigh division, Primrose of the Delano division, and Blackwood of the Blackwood division. The six teams were stationed in a roped-off arena, with over 500 officials and spectators looking on.

Joseph Maher, Daniel Lewis, Joseph Blum. Daniel Jenkins, subject.

Blackwood, 96½ per cent. William Adams, captain, Ray Clemens, Ralph Barr, Henry Krise, John Rhodes. John Lipschack, subject.

Mr. Atherton Bowen, who trains the teams for this company, has had

Fig. 11. Radiant Team, Victor-American Fuel Co.

so much experience in this line that those teams whose members are enthusiasts, are evenly matched, in fact, the five winning teams are but 1 point apart. Mr. John Lloyd has charge of the arrangements of this contest, which includes the lunch and the comfort of the guests, of whom were many prominent in the coal business about Hazleton.

Mr. Chase, the General Manager of this company, is active in promoting any plan that will aid in creating safety in the mines of his company, or that will detract from the sufferings of injured men. The Lehigh Valley is one of the largest anthracite companies, as well as one of the most progressive.

Victor-American Fuel Co.

By F. W. Whiteside

Owing to the long distance separating the company's mines in Colorado and New Mexico, it would be difficult to handle the matter of helmet practice and first-aid instruction under one head. The work has therefore been divided, and each year a separate contest is held at Gibson, N. Mex., and Walsenburg, Colo., to determine the proficiency of the respective teams of the two states.

The initial work attempted along the lines of first-aid under the auspices of the company, had its beginning in May, 1910. In order to stimulate the interest in first-aid practice, a handsome silver cup was furnished by the Victor-American Fuel Co., for a first prize. This becomes the permanent property of the team which wins it three times.

The first contest for this cup occurred July 13, 1912, and was won by the Maitland team, which afterwards took first place in the State Meeting at Trinidad, where first-aid teams from all over Colorado participated.

On account of its central location with respect to the various properties of the company, Walsenburg has been the place selected for holding both Colorado contests. The New Mexico contests are held at Gibson, on account of its central location with respect to the New Mexico mines.

The second annual Colorado contest was held in the baseball park at Walsenburg, August 23, 1913, a large and enthusiastic audience being in attendance. An entry was represented, equipped with a mine telephone, connected to an exterior point representing the mine office, and the standard "danger" and "warning" signs of the company were displayed at appropriate places.

The arrangement of the grounds was in charge of Louis Hufty, assistant engineer of the company. The contest was under direct charge of Chief Surgeon John R. Espey, and the following judges passed upon events: J. W. Amasse, M. D.; H. R. McGraw, M. D.; Capt. George F. Juememann; Harold G. Garwood, M. D. Mr. H. L. Thomas acted as announcer of events.

It is a noteworthy fact that according to the opinion of the judges, most of whom acted in a like capacity a year ago, that the proficiency of the work of the poorest team in this contest, far surpassed that of the best team at the first meeting.

After the sixth event came a representation of a mine disaster, caused by an explosion of black powder. A train of powder was laid for several feet along the ground, terminating at a point near a rock fall. Here at the elevation of the roof of the entry was supported a trap door, hinged at one end, and carried at the other by means of a prop, which, when the latter was released, fell, precipitating a large fall of coal, which had been previously piled upon the door when in its first position. The manner of operating the exhibit was as follows: The train of powder was ignited at the end farthest from the entry; the fire ran along the powder until it reached the site of the fall, when a man, appointed for the purpose, pulled the prop from under the door by means of a rope, precipitating the rock to the floor. This raised a large cloud of dust and was very spectacular. A man working in the entry at a point near where the explosion took place was supposed to be injured by the concussion and fall of rock. A fellow workman in the mine rushed to the telephone and called the mine office, where the Radiant rescue crew, which had been selected for the purpose, manned a stretcher and was soon in the drift, where the injuries of the wounded man first received careful attention; he was then placed upon the stretcher, and carried out over the fall and through the remaining obstacles to the outside.

The specifications for each event were typewritten upon eight separate sheets, each enclosed in a sealed

Fig. 12. Chandler Team, Victor-American Fuel Co.

envelope. As the events were called, the captain of each team was given the sealed envelope containing the specifications, which he read to the team, following which they were

read to the audience. When all the captains had declared themselves ready, word was given to proceed.

Following are the scores made by the teams participating, based on 600 as being perfect:

Chandler, 590; Hastings, 588; Delagua, 584; Gray Creek, 583; Ravenwood, 580; Bowen, 567; Radiant, 560; Maitland, 554.

miner is becoming more skilful in the handling of his patient, and as a consequence, the chances of saving life and limb of the injured in and about the mines, is increased in a like proportion.

The winning teams were composed of the following:

First, Chandler, J. W. Thomas, captain, Walter Saxon, Scott Man-

of the contest; Reese Beddow, state mine inspector was time keeper. The contest was one of the most successful ever held in New Mexico and the judges declared it was one of the best they had ever witnessed.

The annual Colorado first-aid intercompany contests have been postponed, owing to an indecision on the part of the miners as to whether it

Fig. 13. Weaver Team, Victor-American Fuel Co.

Fig. 14. Draper Outside Team, P. & R. C. and I. Co.

As above stated, the first prize consisted of the silver loving cup presented by the Victor-American Fuel Co. In addition to this were second, third, and fourth prizes of $25 each, presented by the B. P. O. Elks, whose state meeting was held in Walsenburg at this time.

It would be difficult to select more efficient judges than those who participated in this contest, as each acted with absolute impartiality and showed no leniency whatever. In order to eliminate the personal equation, the assignment of each judge was changed from time to time, so that different teams came under his inspection, and no one judge, therefore, was able to pass judgment on one team throughout the contest.

A large audience witnessed this somewhat technical demonstration with keen interest, and the proficiency shown in the work by the several teams was highly gratifying indeed, as it demonstrated that the interest in first-aid work is increasing from year to year; that the

ley, Thomas Thomas, John Ylethe, subject.

Second, Hastings, Dave Williams, captain, Tony Arbo, Joe Robinson, John Berthliner, Alex. McBirnie, Jim Natole, subject.

Third, Delagua, S. Dean, captain, F. Richardson, R. Jennings, G. D. Jones, J. Vizas, H. Rice, subject.

CONTEST AT GIBSON, NEW MEXICO

The photograph, Fig. 13, is of the Weaver mine team, winner of the second annual first-aid contest of the New Mexico division of Victor-American Fuel Co., held at Gibson, N. Mex., August 17. Four teams competed, with the following result: Weaver mine, 93; Heaton and Navajo, 92, and Bartlett, 91. This gives to the Weaver team, composed of Ed. Thomas, captain, Thos. Husband, Louis Visconti, Wm. Hamilton, Vede Radosovich, and George Matty, the Victor-American trophy cup for one year. The judges of the contest were C. S. Stephenson and A. A. Flynn, from the United States Bureau of Mines mine safety car which was at Gibson at the time

is good policy to work under the American plan or open shop, or the foreign plan of closed shop. Until this is settled by the men involved in the debate, it is unlikely that there will be a first-aid meet.

Phliladelphia & Reading Coal and Iron Co.

The ninth annual outing and competitive drill of the first-aid corps of the Philadelphia & Reading Coal and Iron Co., was held at Edgewood Park, Shamokin, on Saturday, September 20. It was originally planned to hold the affair at Lakeside Park, but the prospects of inclement weather caused General Manager Richards to shift the scene to Edgewood, where more shelter was afforded. However, the day turned out to be fair, which fact added materially to the pleasure of the occasion.

All of the Reading's 75 first-aid corps engaged in the preliminary contests, the winners of which and their percentages were as follows:

Henry Clay, inside, 96; Tunnel Ridge, inside, 97; Otto, 97; Turkey Run, inside, 96; Knickerbocker, outside, 96½; Good Springs, 96; Bast, outside, 95; Alaska, 90; Draper, outside, 90; Schuylkill Haven Storage Yard, 90.

Draper, outside, won the final contest. The averages were: Draper, outside, 97; Bast, outside, 96; Alaska, outside, 96; Henry Clay, inside, 95; Otto, inside, 94; Tunnel Ridge, inside, 93; Good Springs, outside, 89; Knickerbocker, outside, 85; Turkey Run, 85; Schuylkill Haven, 84.

The winning teams were lined up before President George F. Baer, to receive the pennants. Standing bareheaded in the sunlight, President Baer spoke feelingly to the men. He dwelt first upon the humane character of their work. Next he touched upon the fight which man has to keep up continually with the forces of nature. He told how these forces from time to time gather in volume and sweep away the little barriers that man has set up. The Titanic, the greatest vessel afloat, was equipped with all possible safeguards. It was believed she was unsinkable, when out of the darkness of the night an iceberg loomed up, there was a crash and the noble vessel lay at the mercy of the sea.

Mr. Baer said he had just returned from a tour of Europe, and that during that time he had seen the workmen of many countries. "I want to say," he declared, "that in my travels I never saw a body of men who were finer, in loyalty, in appearance, in efficiency, and in every way, than our own. I am proud of you, every one of you."

The blue pennant was presented to the team winning in the finals, Draper, outside, by Mrs. Heber Smith, of Reading, a daughter of President Baer. The red pennants were presented to the teams winning in the preliminaries, by Mrs. Frank L. Connard, of Reading, also a daughter of President Baer; Miss Helen Richards and Miss Loraine Richards, daughters of Vice-President W. J. Richards; Miss Louise Smythe, daughter of W. F. Smythe, superintendent of the St. Clair Coal Co., all of Pottsville, and Miss Claire Deckert, of Schuylkill Haven.

Caterer Wimbley, of Philadelphia, served an excellent dinner. His corps of assistants consisted of 150 waiters, 25 cooks, and 30 cooks' assistants. The menu was as follows: Vegetable soup, roast lamb, succotash, boiled potatoes, fried oysters, cold ham, potato salad, cold slaw, rolls and butter, ice cream, fine cakes, apple pie, coffee, lemonade.

Morris Williams, President Susquehanna and Allied Companies

The personnel of the winning corps follow:

Draper, outside corps, Morgan Fellows, William Fellows, Norman Timmins, Claude Balliett, Bruch Fellows, Charles Williamson, Charles Smith.

Bast, Frank Oestreich, leader; Walter Bosche, Arch Cranage, Robert Scott, Frank Knauf, Harry Tiley.

Alaska, Edward Delcamp, Lew Clamaskie, Frank Balchonis, Ray Ayers, John Raber, Harry Klinger, John Harbold, John Camp.

Henry Clay colliery, inside, Joseph Demoravage, John Wishnefskie, William Gaskie, Wal. Bartosick, Joseph Glancy.

Otto, inside, Joseph Doran, Lisle Gehres, Michael Hoolihan, George Gottschall, Arthur Tobias, Walter Gettinger, John Williams.

Tunnel Ridge, inside, William Hodgerts, William Oliver, William Moyer, William Ashfield, William Bradley, Herbert Wheat.

Good Springs, outside, Edward Watkins, John Malich, Fred Richter, Albert Watkins, Maurice Fessler, Earl Gauntlett, Lew Koerper, Harvey Loeb, William Laux, John Minnich, Curtiss Ney, Leo Fleming.

Knickerbocker, outside, Samuel Amour, Harry Freeman, Joseph Watson, George Hoover, Charles Hugo.

Turkey Run, Martin Purcell, Patrick Purcell, Thomas Dougherty, Michael Cadden, Charles Lebe, John Coget, Patrick Hand, Thomas Canfield, Louis Shelousky, John Popunas, Thomas Cummings.

Schuylkill Haven Storage Yard, John Troutman, John Nause, Albert Carr, Charles Guldin, Charles Heim.

Susquehanna and Allied Companies

On Saturday, September 13, the Susquehanna and allied coal companies held their fourth annual field day at Edgewood Park, near Shamokin, Pa.

The Susquehanna Coal Co., Mineral Railroad and Mining Co., Summit Branch Mining Co., and Lytle Coal Co., have as President, Morris Williams; as General Manager, Robert A. Quin; and these allied coal companies comprising 14 collieries, sent 43 teams to compete in the first-aid demonstration. In the morning all teams competed, the winners from each colliery being eligible to compete for the championship cup and other prizes in the afternoon.

While the elimination events were in progress two moving picture men, representing Lyman H. Howe, covered the teams' movements, and when the teams were idle awaiting the judges' decisions on their respective merits, "Our Band," of Shamokin, discoursed music which almost made the patients caper even when their legs were temporarily broken. After the completion of the elimination contests at noon the corps and invited guests proceeded

directly to the picnic grounds, where the tables were arranged to feed 1,200. An hour of recreation followed the dinner and at 1:30 P. M., one team from each of the following divisions started to win the cup: Nanticoke No. 5, Nanticoke No. 7, William Penn, Richards, Hickory Ridge, Pennsylvania, Luke Fiddler, Scott, Cameron, Hickory Swamp, Lykens, Williamstown, and Lytle. The winners of the various prizes were as follows: One-man event, Hickory Ridge, outside, medal. Two-man event, Nanticoke No. 5, No. 4 slope, medals. Three-man event, Cameron, outside, medal. Full team event, Scott, outside, medals. The Scott team, which won the silver cup from the Hickory Swamp outside team, the last year champions, was composed of William Horn, captain, Andrew Parker, George Morse, George Lessig, Michael Rafferty. Harper Smith, subject.

During the time the final problems were being solved the Pennsylvania Colliery outside team performed for the moving pictures, going through a number of problems for Lyman Howe's men.

The members of this team are Frank Ramsay, captain, Mason Trefgar, Victor Trefgar, Clayton Smith, William John. Oscar Zimmerman, subject.

Division Superintendent W. R. Reinhardt, who had the details of the arrangements to look after, decided to furnish the people in cities and outside the coal fields an opportunity to see just how anthracite miners looked and dressed, so the Pennsylvania team was arrayed in spotless white from neckties to sneakers. In fact, Phoebe Snow never came off the road of anthracite more immaculate.

After the final events there was a parade in which nearly 1,100 took part. General C. B. Dougherty, Assistant General Manager, who was field marshal, marched his cohorts before the moving picture machines, while the band played. In the parade C. L. Fay, Secretary-Treasurer, and R. D. Norris Hall, Editor of the Coal Mining Institute of America, were observed to be out of step with each other.

After the announcement of the winners and presentation of prizes, General Manager Quin thanked the officials, surgeons, and first-aid men for their cooperation in making this annual field day so noticeably a success. He complimented

General Manager Robert Quin

the first-aid men for their efficiency in the work, which could only have been attained through effort, time, self-denial, and determination on the part of the members of the corps to be of benefit to their fellow men when injured. At times the practice undoubtedly has seemed burdensome, however, the numerous reports of the excellent work done should cheer them, especially the thought that possibly sometime their endeavors will be crowned by saving the life of a fellow man. He then drew attention to a large banner nailed to the right field fence on which was lettered "Safety, the First Consideration," and said: "In the future that is to be the slogan of the allied companies. These companies and their officials fully appreciate their responsibilities so far as the care of employes is concerned, and on September 1 organized what is known as 'The Safety Department.' Good results, however, can only be accomplished by having the cooperation of every employe of these companies, and I am now making a personal appeal to you all to help in this effort to reduce accidents."

Mr. Quin, on the completion of his excellent speech, only a part of which is given, introduced President Morris Williams, whose short address bristled with good will and encouragement. Mr. Williams worked in the mines as a boy with his father, and having been reared in a mining town knows the conditions which prevailed in earlier times and at the present.

He said in part: "I am proud of this magnificent display of interest and enthusiasm in this great work. In looking backward to other years I think of the meager opportunities for gaining knowledge the miners had, compared with what they have now. There has been a wonderful change for the better. The first-aid corps which render such efficient aid and comfort to injured men are a Godsend to mine workers. I would have every official regard his men as wards for we are 'our brother's keeper.' There will be fewer widows and orphans if you watch and see to it that your fellow men are safe. You first-aid corps are semiofficials of these companies. You have shown by your ability to learn the different parts of man's intricate and wonderful mechanism, that you, too, are capable of warning men of danger, and we must look to you for aid in helping us in the safety movement." Before concluding he announced that the members of the Scott team who won the cup were invited guests to the Philadelphia & Reading Coal and Iron Co.'s first-aid meet on September 20. At this Edgewood Park exhibition, the P. & R. C. and I. Co., Bear Ridge Colliery team, winners of last year's events at Lakeside, were guests, as were three first-aid teams from the Pennsylvania Railroad.

Chief Clerk Charles K. Gloman, was in charge of the day's events, as in the three previous contests, and he and the teams are to be congratulated on the smoothness with which the affair was conducted. The visi-

tors numbered between 2,000 and 3,000 in the afternoon with here and there a group of coal operators and officials from other companies exchanging felicitations. The judges of the preliminaries were the company surgeons, Drs. J. M. Maurer, G. M. Stites, B. C. Guldin, and J. H. Hughes, who decided on the work of each other's teams. The final events were decided by Drs. J. B. Rogers, of Pottsville; D. H. Lake, of Kingston, and James W. Geist, of Wilkes-Barre. Special trains were chartered to carry the teams and invited guests from Wilkes-Barre and Lykens, while large numbers of others came from Shamokin, Pottsville, and surrounding towns on regular trains.

Lehigh & Wilkes-Barre Coal Co.

The Lehigh & Wilkes-Barre Coal Co., is one of the largest companies that mine anthracite in the Wyoming district of the northern anthracite field, and in the Hazleton district of the north-central anthracite field. During the summer and fall of 1901, this company installed emergency hospitals, in accordance with the law, in all their collieries. These were provided with emergency chests, containing bandages, splints, and the necessary appliances for treating and caring for injured employes.

The late Dr. F. L. McKee was appointed company surgeon, to look after the equipment of these hospitals and to instruct the colliery officials, and others interested in the work of how to treat various kinds of injuries. A large number of employes, as well as officials, and first-aid corps, have been instructed in first-aid work. When this company recently erected its magnificent office building, overlooking the Susquehanna River, at Wilkes-Barre, a large lecture room was included, in which the men meet and receive instruction.

The first-aid work was inaugurated by this company in 1902, when Doctor McKee commenced instruction. The team work followed shortly afterwards. At first the instructions were principally for the mine officials, as the law of 1901 practically demanded that the foremen should be first-aid men and care for injured miners, although it made no provisions for their instruction or recommendation how they were to obtain first-aid information. The value of Doctor McKee's lectures to these men was appreciated by all, as they commenced at a time when most needed.

For the past 4 years it has been the custom of this company to hold an annual field day, at which all the first-aid corps from its different operations, enter into competition, to determine which is the most proficient in this kind of work. As an appreciation of the men's endeavors, the company gives an outing, luncheon, and prizes, to those teams obtaining the highest average mark at the contest. Last year, 12 collieries entered 26 teams; this year, 14 collieries entered 36 teams, besides a team of boys from the Wanamie colliery. This was the fourth annual field day, and was held in Sans Souci Park, near Wilkes-Barre, August 30.

The exercises commenced at 9:30 A. M., and lasted throughout the day. There were eleven events on the program, seven of which were elimination contests to qualify teams from the various districts for the eighth or final championship event. Those teams which won in the preliminary contests received pennants, and the team which was the winner in the final event, received bronze medals.

1. All outside corps competed on one problem. The Buttonwood team, composed of the following men, won: David J. Williams, captain, Walter Griffith, Gottlieb Schwall, John Emmanuel, Harry Bryant, Edward Jacobs.

2. All inside corps of the Wilkes-Barre and Ashley districts competed on one problem. This event was won by the Empire colliery inside team, composed of Joseph Stevens, captain, Walter Powell, John Flannagan, Roy Lowe, John Moran, Daniel Ward.

3. This event was between inside teams from Plymouth and Honey Brook divisions. It was won by the Parrish inside team, from Plymouth. The names of the men composing this team are William J. Jones, captain, Alfred Reed, William Morris, Wade Maxwell, Edward Loughlin, David Jones.

4. In this event all outside and inside corps from the Wilkes-Barre district competed on one problem. The event was given to the Stanton colliery outside team, composed of W. H. Hetherby, captain, William Rainow, Thomas Harten, Anthony Monahan, John Minnick, John Flaherty.

5. In this competition, all inside and outside teams of the Ashley district competed. The Sugar Notch team won the event. Its members are Thomas Roach, captain, Harry McDermott, Edward Roach, Benjamin Comstedt, Daniel Lewis, Anthony Morris.

6. All the inside and outside teams of the Honey Brook division, composed of the company's collieries around Hazleton, competed on one problem for the pennant. The event was won by the Audenried colliery outside team, composed of the following men: T. O. Mader, captain, Arthur Young, James Dougherty, James Roberts, Philip Lewis, Charles Gildea.

7. In this event the outside and inside teams of the Plymouth district played for the pennant, and there was considerable rivalry between the Nottingham outside and the Lance inside teams. The Lance team won the championship last year with the Nottingham a close second, and in this event the two tied, and were given opportunity to work in the final event. The Lance team was composed of the following men: Ray Lewis, captain, John Cummings, Hugh Kane, James J. Lewis, John D. Edwards, Thomas Lewis.

The Nottingham inside team was composed of the following men: William James, captain, John Pritch-

ard, James Colbert, William Berkheiser, Michael Rubic, Anthony Adoski.

8. This event was an exhibition by the breaker boys team of the Wanamie colliery. Their work was exceptionally good, and received commendation from the different corps and from the spectators generally. One boy gave an exhibition of roller bandaging, beginning at the foot, then the ankle, knee, thigh, and hip. Another boy bandaged the hand, arm, shoulder, and chest. This team has been drilled for several months, and is considered by Dr. J. W. Geist, who took Doctor McKee's place, as a very efficient first-aid corps, although none are much, if any, over 16 years of age. Their names are John Craig, captain, Thomas Stoker, Thomas Crouse, Frank Stoj, Walter Shershing, Forrest Rinehamer.

9. This was the championship event between those teams in the previous events, who won pennants. Last year there was a remark made, "What did outside teams know about inside first-aid work?" This year, the Nottingham outside team, which won the championship, could reply by asking, "What the inside teams knew about first-aid work outside?" The victory of this team is more remarkable because there were three new men on the Nottingham team and but one new man on the Lance team, which made it almost a 1912 team.

10. This event consisted of a substantial luncheon, at which there were speeches and songs. General Manager, Charles F. Huber, was toastmaster, and in a happy vein, thanked the teams for the interest they had taken in the first-aid work, which was not only an encouragement, but a great relief to him to know that there were men at the collieries which he managed who could be depended upon to do all in their power to alleviate the sufferings of the injured and possibly save lives. John H. Biglow, Esq., of Hazleton, then presented the medals and pennants.

11. This, the last event, was an excellently played baseball game, between the lads from around Wilkes-Barre and those from around Hazleton. The score was small and close, and either the Hazleton or the Wilkes-Barre team won. This being written in Scranton, naturally our sympathies are with the Hazleton team, although we disremember who did win.

Dr. E. C. Wagner, was judge of the contest, and two or three times he was obliged to refer to Doctor Geist, the instructor, for some particulars, in order to prevent ties. This gave the daily press the impression that he was a judge, when in reality he had charge of the meet, and nothing whatever to do with the judging. Altogether, it was the most successful Field Day in every way that this company has had, at least all of the 600 who took luncheon are inclined to believe that it was.

Fig. 17. Brisbin Mine Team, D., L. & W.

Fig. 18. D., L. & W. Team Lifting Man Over Six-Foot Fence

Delaware, Lackawanna & Western Co.

On September 13, the Delaware, Lackawanna & Western Railroad Co. held a first-aid contest at Scranton, in the field near the Dodge colliery. Teams representing both the Coal Department and the Railroad Department competed, under the management of Dr. J. M. Wainwright. The judges were Doctors H. M. Neale, Geo. M. Cody, H. F. Smith, R. T. Wall, and B. H. Jackson.

In the first contest, which was to pick the best team from each district, 17 teams from mines in Districts 1, 2, 3, and 4, and 9 teams from the Railroad Department, competed.

In the Coal Department, the winners were as follows: 1st District, Brisbin; 2d, Sloan; 3d, Bellevue; 4th, Bliss. In the Railroad Department the winners were: Foundry, Keyser Valley, and Bangor-Portland.

The second contest was between the winning teams of the first contest, and was for the championship of the Coal and the Railroad departments.

In the contest, the Brisbin team won the championship and with it the Superintendent's Cup, formerly

held by the team from Central, and $2 cash for each member of the team.

The Foundry team was second, and received a cup known as the Y. M. C. A. Cup, for which only railroad men are eligible to compete, and $2 cash for each member. The Bellevue team won second prize among the mine teams, and received $2 cash for each member.

The final contest was between the Brisbin and the Foundry teams, for the championship of the entire system, and carried with it the President's Cup, won last year by the Foundry, and a $3 cash prize for each member.

The winners were the Brisbin team, which consisted of the following: John Pierce, captain, James Higgins, George Bennett, John Schrader, Frank Jones.

It was evident from the list of events, that the test was a severe one covering a great variety of accidents, and it can truthfully be said that the work of all the teams was of a high grade. An injured man falling into the hands of even the lowest ranking team might consider himself fortunate.

The dangers to which the workers are exposed is painfully illustrated in the case of one of the competing teams, the Woodward Red Ash; this team has always ranked high, having taken part in the National Mine Safety Demonstration in Pittsburg, in 1911, the Red Cross meet at Washington, D. C., in 1912, and the recent meet held at Harvey's Lake, Pa., in August. On the Tuesday following the latter meet, their captain, David Phillips, was killed in the mine, and his loss is deeply felt by his comrades on the team.

This company sent five teams to compete in the Anthracite Red Cross contest for the Muckle Cup; the four district teams mentioned, and the Storrs colliery team. Reference to the account of the Anthracite Red Cross contest will show that little difference is to be found in the work of the best and poorest teams. General Manager Phillips, was in attendance, but President Truesdale, who takes considerable interest in first-aid work, was unavoidably absent. Mr. Charles E. Tobey, Superintendent of the coal company distributed the prizes.

Pennsylvania Bituminous First-Aid Meet

On Saturday, August 23, the Second Annual Bituminous First-Aid Meet of Pennsylvania was held under the direction of the Bituminous Committee of the State Y. M. C. A., at Oakford Park, near Connellsville, Pa.

There were 25 teams entered, representing the following companies: Jamison Coal and Coke Co., Westmoreland Coal Co., Penn Gas Coal Co., New Alexandria Coke Co., Republic Iron and Steel Co., Manor Gas Coal Co., Tower Hill-Connellsville Coal and Coke Co., West Penn Railways Co., Consolidated Coal Co., and the Pittsburg-Baltimore Coal Co.

Major Robert W. Patterson, Medical Corps, U. S. A., was the presiding judge. The Bureau of Mines was represented by C. O. Roberts, of Pittsburg, and the Red Cross by Dr. W. N. Lipscomb, of Washington.

The teams, headed by a band, marched to the demonstration field. There were three teams of women, wives and daughters of the members, two from the Pittsburg & Baltimore Co.'s mines, near Irwin, and one from the Andrico mine of Herminie. These teams gave demonstrations of how to treat fractures and burns, and of artificial respiration. The test problems numbered 34, thus including many accidents that happen in the mines. The prizes consisted of a handsome silver cup, presented by the state committee, six sets of self-help mining lessons, an American Red Cross cabinet, and Red Cross medals.

Major Patterson selected Dr. S. W. Ferguson, of Gallitzin, Pa., Dr. Edward Pargoe, of South Fork, and Dr. R. S. McKee, of Connellsville, as his aids in the demonstration. The judges declared the following winners: First, the Magee team of the Westmoreland Coal and Coke Co., silver cup and Red Cross and American Mine Safety medal, with 97 points. Second, the Jamison Coal Co. team of Crabtree, with 96⅓ points. Third, the Penn Gas Coal Co., of Penn Station, with 96⅔ points.

An account of this meet would be incomplete without mention of the women's auxiliary teams. As women do not work in or about the mines in the United States, such teams seem superfluous, until one thinks of trained nurses in cities and then of the lack of such nurses in mining communities. While the teams are trained in first-aid and wear Red Cross pins, their particular line of endeavor is to go into the homes of the sick and injured and help care for them.

On thinking over this matter and how much women can do to relieve the mother who does housework and cares for her sick child or injured husband, these women's auxiliary teams should be accorded as much commendation as the men. At the second annual contest between women teams the New Alexandria Coal Co. team won with a mark of 98. The Edna No. 2 mine team of the United Coal Co., received a mark of 97 and the second prize. This team is shown in Fig. 19; the members, reading from left to right, are the Misses Sara Kettering, captain, Viola Robbins, Annie Sheridan, Mary Miller, Helen Dickson, and the subject is James Kirwin.

Edna Mine No. 1 team, which won third prize, is composed of the Misses Laura Bishop, captain, Leota Hutton, Nelly Alcorn, Lillian Hamilton, and Emma Campbell.

This annual bituminous meet in Pennsylvania is due to the energy displayed by Mr. T. B. Dilts, of the Greensburg Y. M. C. A.

Mine Rescue Crews in Kansas

At a recent meeting of operators, U. M. W. of A. officials, and representatives of the state mine inspection department, steps were taken

toward the organization of trained rescue crews for mine accidents. A committee composed of President Alexander Howat for the miners, Commissioner George Richardson for the operators and State Mine Inspector Francis Keegan, was named to formulate a plan by which the three interests represented by them shall cooperate in the work of forming rescue organizations and providing training and practice for the members of the crews.

The function of the crews, which will be chosen from the employes of the various mines, will be to go into the mines immediately after explosions or serious accidents, and start the rescue work without having to wait for the arrival of the rescue car. It is proposed to train them thoroughly in the use of oxygen helmets, the pulmotor, and in the safest way to reach imprisoned miners.

W. D. Ryan, who represents the United States Bureau of Mines, urged the need of apparatus and trained crews at every mine. Such organizations, he declared, would result in the saving of lives which would be lost if it were necessary to await the arrival of the rescue car before going into a mine after an accident.

Mr. Richardson declared that the three men at every mine who first of all should equip themselves with this knowledge are the mine foreman, the pit boss, and the gas man, and he strongly favored the proposal to organize for the purpose of training crews to lead the rescue work.

It was brought out that in the cases of past accidents the rescue parties have been most seriously handicapped by the lack of competent leaders and trained men. The plan, if adopted, and carried into action by the committee appointed for the purpose, is calculated to remedy this condition.

President Howat said: "The time is coming when every mine will be equipped with helmets and pulmotors. They may be installed voluntarily, or by provision in the contract, or by state law, but the point is that they will be installed. If our mines had been thus equipped in the past, even since the invention of the pulmotor, many miners who are now in their graves today would be living."

Francis Keegan, state mine inspector, said Kansas mining conditions are preeminently more dangerous than those of any other state. He earnestly commended the idea of forming rescue crews of specially trained men, and concluded by promising the support of the inspection department in every way. "There's nothing we are not willing and anxious to do to help this movement along," he said.

Fig. 19. Edna No. 2, Women's First-Aid Team

Fig. 20. Winners in Pennsylvania-Hillside Contest

The Pennsylvania-Hillside Contest

The Pennsylvania Coal Co. and the Hillside Coal and Iron Co. held the annual intercompany contest for their first-aid teams at Valley View Park, Inkerman, Pa., on September 20.

These companies have collieries scattered from Forest City in the northern end of the Lackawanna coal field to Pittston in the southern end. On this occasion the teams were picked from 12 collieries to compete for the May Cup and to see who should represent their districts at the Red Cross contest at Inkerman on September 27. The team that is successful in winning the May Cup 2 consecutive years, owns it, and heretofore the Law shaft team, from Avoca, seemed to have had it mortgaged. Indeed, this year they expected to attach another cup, for they won it in 1912. The team members claimed that the absence of their veteran captain, George L. Kellum, was the cause of their failure this year.

Dr. F. F. Arndt, who has been director of the first-aid work for these companies since Doctor Shields left to take up similar work for the Red

Cross Society, officiated as field marshal. The other officials were F. H. Coughlin, F. D. Conover, Edgar Weichel, H. P. McMillan, inspector for the company in the southern district, and Superintendent William P. Jennings, of Pittston.

Besides the company officials, there were a number of men from other coal companies in attendance and in the afternoon a fair sprinkling of women, who seemingly are taking more general interest in first-aid contests everywhere than heretofore.

The judges, Drs. F. J. Bishop, Edgar Sturge, and B. B. Wormser, of Scranton, marked the teams as follows:

Fernwood Slope team of the Butler colliery, of Pittston, Fig. 20, received a mark of 98⅜; this being the highest mark, they won the cup.

Old Forge colliery, Avoca, 96; No. 5 shaft, No. 6 colliery, Dunmore, 95⅛; Law shaft, Avoca, 95; Erie colliery, Dunmore, 91⅛; No. 5 shaft, Dunmore, 90; No. 6 breaker, South Pittston, 90; Erie shaft, Mayfield, 89; No. 2 shaft, Forest City, 85⅛; No. 1 No. 9 colliery, North Pittston, 87⅛; Forest City, 82.

Heretofore, the officials in charge have usually worked out some spectacular problem. This year they furnished a high canvas enclosure, in which only the judges and two men could find room.

The reason for this was that an expensive Howard gold watch was donated by the company as a prize for the one-man event and it was worked out where the other competitors could not obtain a view of how the men solved the problem, and thus gain any advantage. The watch was won by Lewis Heal, of North Pittston.

One man from each district was eligible to compete for the watch, provided he had received 100 per cent. for his attendance at the meetings of the team for 10 months prior to the first of June. As a second prize for the one-man event, a pair of gold sleeve buttons was given.. These were won by John O'Malley, of Mayfield. A silk umbrella was awarded to William Creeden, of Avoca, who had the third highest mark.

The Pennsylvania-Hillside companies have about 60 teams which hold district contests in June. The winners in these contests take part in the annual contests, and the winners in the annual contests are entered in the Anthracite Red Cross meet for the Muckle Cup.

Lehigh Coal and Navigation Co. Field Day

The first field day of the Lehigh Coal and Navigation Co., was held at Lakeside Park, East Mahanoy Junction, August 30.

A special train carrying first-aid teams, colliery officials, and a band of 30 pieces, left Lansford at 8 A. M., stopping to pick up guests at Coal Dale, Seek, and Tamaqua.

The first-aid contests were held immediately on the arrival of the train at the park. Twenty teams were entered. No. 8 slope won with a mark of 98.8, with No. 3 slope last with a mark of 92. Such close marking resulted in 15 teams getting mixed up in six ties, but it shows that the teams are receiving thorough training from Dr. J. H. Young, and his assistant, J. L. Simons.

The first prize of $25 in gold and a silver medal for each member, was won by Slope No. 8 team, composed of: Thomas J. Evans, captain, John Rimbach, Evan Phillips, Arthur Jeffries. John Neznamy, subject.

The second prize of $15 in gold, was won by the Lansford outside team, with a mark of 98.4.

The personnel of the team was Alexander Gibson, captain, Ernest Huegal, Howard Lesher, Grant Blyler. Joseph O'Donnell, subject.

Gold to the amount of $10 was distributed as a third prize to the Springdale team, who received a mark of 96.8, although No. 11 shaft tied at 96.8. The Springdale team had the following members: Thomas Whildin, captain, John Pasco, John Haughton, James Monroe. David Griffith, subject.

After the first-aid contests, Headquarters, Nesquehoning, Lansford, Coal Dale, and Greenwood districts engaged in water sports, such as swimming and rowing. These being concluded, 600 tried to see who could devour the most fried chicken, and then one-half hour after dinner the jumping and running contests were held. The district which had the highest number of points won the cup offered as a prize.

Immediately after the close of the field sports, the two leading teams in the Old Company League played a game of baseball for $25. Considerable adverse criticism has been made because beer and sandwiches were permitted the hungry in the forenoon; the critics, however, are probably hierophants in the occult science of dry-munching sweitzerkase sandwiches. Three liters without collars will beerhydrate three sweitzerkase sandwiches, and no natural person can devour three such sandwiches without hydration, which shows that some people would deprive others of food. Assume for argument, that 300 of the 600 did indulge in three sweitzer sandwiches and three liters for hydration purposes; then 300 would have the chicken that was intended for 600, yet all would be satisfied.

This is a case of theory versus practice.

Bituminous First-Aid Movement

The first-aid movement in the bituminous coal fields seems to have been agitated in 1907 by representatives of the Young Men's Christian Association.* Dr. J. W. Hawes, of Windber, Pa., read a paper on First-Aid to the Injured, before the Y. M. C. A. District Mining Institute, at Johnstown, Pa., July 23, 1907. The Frick Coke Co. was also considering the movement, for Dr. M. J. Shields writes: "I went to Scottdale in the fall of 1907, at the request of C. L. Lynch, assistant general manager, and talked over first-aid organization, but that company did not take

*C. L. Fay Mining Work Secretary, up to 1910.

it up at that time." The first series of lectures on first-aid work in the bituminous coal fields was given to the employes of the Latrobe Connellsville Coal and Coke Co., and the Loyanhanna Coal and Coke Co., at Latrobe, Pa.*

Dr. L. C. Thomas and Dr. Albert Aber lectured and gave demonstrations of practical first-aid work. In 1910 Mr. Fay induced Dr. M. J. Shields to go to the bituminous field, and the first work he did after joining the Red Cross was started February 1, 1910, when instruction was given employes of the Keystone Coal and Coke Co., Jamison Coal and Coke Co., the Westmoreland Coal Co., the Rochester and Pittsburg Coal and Iron Co., the Pittsburg-Buffalo Co., and the United Coal Co. Doctor Shields remained in this field until March 15, and gave instruction to these companies in the order named.

From Pennsylvania Doctor Shields went to Oklahoma, from there to Alabama, and then West Virginia.

In August, 1910, in conjunction with Prof. J. J. Rutledge, of the United States Geological Survey, Doctor Shields lectured in Tennessee and in three or four places in Kentucky, Stearns being one. In the fall they returned to the Central City district of Kentucky. In October, 1910, the United States Bureau of Mines sent out its first instruction car from Pittsburg over the bituminous field of Pennsylvania. Doctor Shields accompanied this car as far as Scottdale, where he remained about 6 days, after which time the first-aid lectures were given by the Geological Survey's first-aid instructors. Mr. Charles Enzian was in charge of this car, whose itinerary, starting at Pittsburg, lasted 6 weeks, and ended at State College.

In the fall of 1910, the Bituminous Committee of the State Y. M. C. A., engaged Mr. W. T. Thomas, a practical first-aid instructor of Du Bois. Mr. Thomas gave lectures under the Bituminous Committee to the employes of the Pittsburg Terminal Railroad Co., the Rainey Co., the Republic Iron and Steel Co., Tower Hill Connellsville Coal and Coke Co., the Buffalo, Rochester and Pittsburg Coal and Iron Co., and a number of other companies. In December, 1910, at the invitation of General Superintendent, Walter R. Calverley, T. B. Dilts, the Mining Secretary of State Y. M. C. A., and W. T. Thomas went to Windber and presented the first-aid movement to the employes of the Berwind-White Coal and Mining Co. Mr. Thomas gave a lecture on first-aid, and followed it by a number of demonstrations. Mr. Calverley was so well pleased with Mr. Thomas' simple presentation of first-aid that he asked that the Bituminous Committee arrange to have Mr. Thomas come to Windber and give a number of weeks' instruction to the company's employes. In January, 1911, Mr. E. E. Bach, who then was employed by the Y. M. C. A. Bituminous Committee, together with Mr. W. T. Thomas (also in the employ of the Bituminous Committee), went to Windber, and after one week's work in organization, enrolled about 225 men in classes. At this time Mr. Calverley felt that they ought to have a man to give all his time to their work and Mr. W. T. Thomas was engaged by the Berwind-White Co., to carry on the work systematically.

*T. B. Dilts, Greensburg Y. M. C. A.

Fig. 21. Winners of First Prize, Lexington, Ky., First-Aid Contest

In the early part of 1911, the Colorado and New Mexico first-aid corps were organized, so far as can be learned, and in September, 1911, the first Rocky Mountain intercompany contest took place at Trinidad Fair Grounds.

It is safe to say now that from the introduction of the Government's instruction car, first-aid work became general in the coal fields throughout the United States.

In 1911, the Bureau of Mines at Pittsburg induced a number of Western Pennsylvania coal mining companies to send teams to a first-aid meet, prior to the teams entering the National Safety Demonstration

Since that date there have been similar meets in western Pennsylvania, and Mr. Dilts, of the Y. M. C. A., has been instrumental in promoting several, one at Johnstown, Pa., in July, 1912, two at Oakford Park in 1912 and 1913, and possibly others.

Colorado held its first intercompany contests in September, 1911, Kentucky in May, 1913, and Tennessee in September, 1913.

Correction

Mr. David Victor calls attention to a slip in the typewritten copy of his paper, published on page 99, The Colliery Engineer of September.

The second sentence from the bot-

tom of column two, should read: "From this it can readily be seen that the quantity of air rather than the quantity of dust or coal, is really the measure of the magnitude of an explosion."

What is Coal Land?

It is so often the unpleasant duty of the United States Geological Survey to refuse to reclassify as non-coal land areas that have been classified as coal land, because the evidence and affidavits submitted for reclassification are inadequate, that a word of explanation on what is considered "adequate" may make clearer the position of the Survey.

It is a widespread popular impression that if coal is found outcropping on a tract, the land is coal land, and that if no coal is to be found outcropping the land is non-coal land. If this were true probably more than one-half of the coal produced in the country (in some states more than 95 per cent.) would be coming from mines not on coal land.

As an illustration, 196 mines in Indiana in 1908 produced 11,997,304 tons of coal. Of these 196 mines, 15 were working the coal from the outcrop and produced 400,733 tons, or a little over 3 per cent. of the total. The rest was mined from land, the surface of which showed no coal. In Illinois the percentage is still less, and in both states the average production of the mines working on the outcrop is small, compared with the average of all the mines. The percentage of coal worked from the outcrop is greater in Pennsylvania, West Virginia, and the Southern Appalachian States than in the two just cited, but not much if any greater in the Michigan field, the western interior field, or some others of the large fields of the country. It is true that in many of the fields, when first exploited, mines were mostly driven in on the outcrop, but for two reasons that condition has greatly changed: First, the coal close to the outcrop has been mined out; and second, after a time it has been found to be cheaper to mine the coal from shafts sunk to the bed from a point some distance back from the outcrop than to haul the coal, water, and waste up the slope of the bed as it pitches into the ground.

If, therefore, any producing coal field is examined there will usually be found a belt of outcrop in which the coal-bearing rocks rise to the surface of the ground and outside of that belt an area, which may amount to thousands of square miles, where the coals are all below the surface and the surface rocks may even be of entirely different age and perhaps may not be coal bearing at all. If in any tract a bed of coal of workable thickness outcrops, it evidently does not underlie all and may underlie only a small part of the tract, and to that extent the land is not coal land, so that it sometimes happens that a bed of coal outcrops or is exposed on a given tract and yet underlies so small a part of the tract that it would hardly be fair to consider the whole tract as coal land.

In Indiana shafts have been sunk to coal beds at a depth of 250 feet without any preliminary drilling where the coal bed did not outcrop nearer than 15 miles, and many of the mines of Illinois are 25 to 50 miles from the nearest outcrop of the coal they are working.

In classifying coal land a few general principles are involved:

1. If the land is known to be underlain only by groups of rocks known nowhere to contain coal, the land is assumed not to be underlain by coal and to be non-coal land.

2. If land is known to be underlain by one or more groups of rocks known to contain workable beds of coal, and a study of the dips shows that these groups are not too deep for the coal they contain to be worked, the land may be presumed to be coal land.

In nearly all cases where public lands have been withdrawn pending examination and classification, it is known or believed that the land is underlain by groups of rocks known elsewhere to contain workable beds of coal. In probably a majority of cases it is also known, or later examination demonstrates, that coal does not outcrop on most of the land withdrawn but underlies it, perhaps at a considerable depth.

Given, then, an area of public land withdrawn for examination and classification, under what conditions will it be classified as non-coal land?

1. Detailed examination may show that the coal-bearing group of rocks may have thinned out before reaching the area, so that although the rocks above and below this particular group are found to underlie the area and normally this particular group should also, yet under the circumstances, if this is the only coal-bearing group in the region that might underlie the area, it is classified as non-coal land.

2. Detailed study of the dip and lay of the rocks may show that the coal-bearing group lies deeper than the limiting depth imposed by the departmental regulations governing the classification of coal land, and the area must therefore be classified as non-coal land.

3. Detailed study may show that the area is underlain by a coal-bearing group of rocks within minable depth, but the coal is too low in grade to be worked, or it may be found that the coal occurs only in local pockets, none of which are thought to extend under the area involved.

Illinois Coal Statistics

Summary for the Years Ended June 30, 1912 and 1913

	1913	1912
Number of mines and openings of all kinds	840	879
New mines or old mines reopened during the year	85	176
Mines closed or abandoned since last report	124	142
Total output of all mines, in tons of 2,000 pounds	61,846,204	57,514,240
Number of shipping or commercial mines	371	380
Number of motors in use	466	381
Number of mining machines in use	1,661	1,581
Number of tons undercut by machines	30,228,520	25,550,019
Number of tons mined by hand	31,617,684	31,964,221
Average number of employes underground	71,063	70,836
Average number of boys employed underground	1,430	1,526
Average number of employes above ground	7,004	7,049
Total number of employes	79,497	79,411
Average price paid per gross ton for hand mining, shipping mines	$.664	$.636
Average price paid per gross ton for machine mining	$.521	$.496
Number of men accidently killed	177	180
Number of gross tons mined to each life lost	349,414	319,524
Number of deaths per 1,000 employed	2.23	2.29

Hydraulic Filling as Roof Support

The Advantages of the Method as Shown by Experience on the Continent—a Consideration of Some of the Difficulties

By George Knox

IN HIS paper* on "The Relation Between Subsidence and Packing, With Special Reference to the Hydraulic Stowing of Goaves," Mr. George Knox furnished some interesting matter, from which these notes are abstracted.

The distrust with which the hydraulic filling process was received 20 years ago is now removed except in Great Britain, owing to the successful results which have attended

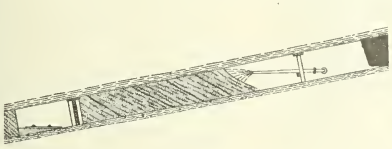


Fig. 1. Method of Hydraulic Packing to Dip of Coal Face

Fig. 2. Hydraulic Packing in Flat Workings

Fig. 3. Creep

its application, and in many cases, to quote the words of G. S. Meyer, of the Shamrock collieries, Herne, Westphalia: "It has resolved itself into a system of necessity."

In the metalliferous mines of Western Australia hydraulic packing has been in use with satisfactory results for the past 15 years, and costs about 20 cents per ton of ore extracted. It has also been introduced in the Transvaal mines, where, according to the Robinson Gold Mining Co., Ltd., the mines have become safer, the ventilation has been improved, the ore reserves have been increased, the old pillars reclaimed, the workings carried to greater depths, and the old dump heaps removed.

In Upper Silesia over one hundred collieries have installed this filling system in coal seams varying from 4 to 40 feet in thickness, and have thus reduced the subsidence of from 30 to 70 per cent. down to .3 to 7.8 per cent. of the total height of the seam. Spontaneous combustion, which accounted for a loss of 25 per cent. of the total area of coal, has been eliminated, surface damages have been reduced, and a great saving effected in timber. The cost of packing varies from 10 cents per ton of coal mined at Myslowitz, to 14 cents per ton at Florentina colliery, and from 16 cents to 18 cents per ton at the Kattowitz collieries.

In Westphalia, hydraulic filling is increasing from year to year, and it is considered that the majority of the coal mines will be obliged to adopt this system. Where sand is used hydraulic stowage is cheap, and is said not to amount to more than 12 cents per ton; but in cases where more expensive material has to be mixed and ground before use, the cost of stowage is 25 cents per ton. It is maintained that with hydraulic stowage the expenses for pit timber are reduced and the total coal output per annum increased.

When it is considered that under the old system of work the loss of coal is, in some cases, from 40 to 50 per cent., and that Germany's total output in 1910 amounted to 153,000,000 tons, it would mean a dead loss (taking only 20 per cent. as an average loss) of coal left in the pit of about 30,000,000 tons, an enormous saving of national wealth being possible in the adoption of hydraulic stowage, which is so simple and inexpensive. Assuming the production in the United Kingdom to be at the very least 270,000,000 tons per annum, there would be a saving of 54,000,000 tons per annum at least.

In the Saarbrucken district there are over twenty independent hydraulic-filling installations, costing $350,000, on the state-owned land, having about 25 miles of piping and using the old weathered pit dump heaps for filling material. The cost there is slightly higher than for hand packing, but this is more than counterbalanced by the decreased cost for timber and surface damage, and the prevention of gob fires.

Other German collieries, including the Shamrock, Deutcher, Consolidation, etc., have all had experiences similar to those quoted, as well as those collieries in the French, Belgian, and Austrian coal fields, where hydraulic filling has been tried.

For a description of the plant and principles involved in hydraulic filling or flushing, see volumes 32 and 33, Mines and Minerals.

A brief summary of the experience gained by engineers in other countries where this system has been tried may show that, while there are very real difficulties, they are not insurmountable, and, if an opportunity is afforded, there need be no fear of failure on the part of mining engineers and colliery managers in Great Britain to cope with each difficulty as it arises quite as successfully as engineers in other countries have done.

Cost of Providing Packing Material.—In newly opened coal fields where a plentiful supply of sand or other suitable surface material for packing could not be conveniently secured, this might be a costly dif-

*From the Transactions of the Manchester Geological and Mining Society.

ficulty. As a general rule in this country, where mining has been in progress for many years, the high pit, cinder, slag, and other refuse heaps, which disfigure most mining districts, would provide a supply of packing material capable of satisfying the needs of the present working collieries.

Where sand is plentiful, this forms the cheapest and most efficient packing material, costing, in Upper Silesia, from 6 cents to 8 cents per ton of coal raised; but where local weathered pit heaps are available, the cost is said to be from 10 cents to 14 cents per ton.

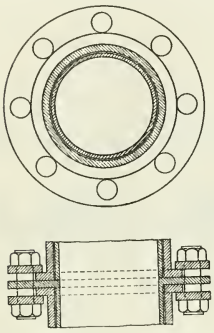


Fig. 4. Sections of Joint of Steel-Lined Pipe

In Essen, and other thickly populated centers, the money saved in ground rents by getting rid of refuse heaps, and the saving of from 8 cents to 10 cents per ton for surface damages, reduces the total comparative cost of hydraulic filling to a very small sum compared with the old system.

Where slag or other refuse has to be transported for considerable distance by rail, as at Saarbrucken, the cost may become as high as 20 cents to 25 cents per ton, about 6 cents per ton higher than for hand packing, but the difference is made up in the saving effected in the timber.

In Upper Silesia the coal owners have formed an association which has purchased large tracts of agricultural land where sand is available, and are constructing railways to transport the material to the various mines. It is evident that the coal owners of Saarbrucken consider hydraulic filling to be very advantageous when they are prepared to make the necessarily large outlay entailed by this scheme in order to get sufficient packing material.

Not only would it be possible to find a sufficient supply of packing material in this country, and at very small cost, but the other advantages incidental to the removal of such supplies would in themselves be a sufficient incentive to warrant the adoption of hydraulic filling.

Difficulty in filling flat or slightly inclined underground excavations is not so great as it is generally assumed to be, and as Mr. Keith, in his report to the Town Council of Hamilton, on this system remarks, "in the practical work of filling there is no more difference than in filling a box on the tilt with sand, and filling it with sand on the flat."

With a dip of 5 degrees or more, as in Fig. 1, and the flushing shaft on the rise side of the royalty, there is little difficulty in carrying the filling material into the goaf for a horizontal distance along the levels of three to five times the "head"; according to the percentage of water used. It is not advisable to force the filling in the pipes uphill, although this is frequently done for a distance of 30 to 40 yards, because of the excessive amount of water required.

In flat seams the filling is kept in position by temporary walls of timber, as shown in Fig. 2, raised sufficiently high across the pack area to prevent the flushed material from spreading too far back. These boards are laid in loose between two lines of props, and moved forward as the goaf becomes filled up.

In France and Belgium, where the coal seams are frequently overfolded, the hydraulic system has been successfully applied, under more adverse conditions than are commonly met with in this country.

Among the difficulties due to the use of large volumes of water underground, are the following:

Creep.—This heaving up of the floor when too much of the roof support has been taken away (whether in bord-and-pillar or in longwall working) is the result of the movement of the rock particles in the floor from the point of greatest pressure (under the pillar or pack) toward the point of least pressure, the gate road or open goaf, and is usually coincident with floors consisting of consolidated muds free from cements.

The coal pillars, or packs, are forced into the floor by the weight of the overlying strata, the rock particles being translated horizontally toward the open gate roads or gobs, Fig. 3. If water is present, it acts as a lubricant between the particles and accelerates the movement; but there are few rocks found as underclays that will "swell" when moistened, unless there is "creeping" of the particles resulting from great pressure accompanying it.

By means of hydraulic filling the primary cause of creep can be reduced to a minimum by the greater amount of support left in the mined area and the more even distribution of the total weight on the packs, as only a few gate roads are necessary. If this system be applied to the retreating method of working, the wet floor is always being left behind, and as the old gate roads are usually fitted with rubbish dams, and the water from the packing area is turned into them, they act as settling ponds and become silted up, thus completely packing all the mined area and consequently reducing the tendency to creep.

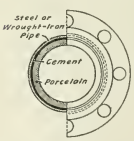


Fig. 5

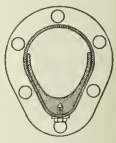


Fig. 6

Increased cost of pumping in connection with this filling system would be a great disadvantage in many mines, particularly in Lancashire, where very little water is met with in the lower workings of the deep

mines, as it would necessitate the erection of a special pumping plant for pumping the water back to the surface. Pumping gritty water is wearing on pumps, but this feature has been considerably reduced on the continent by the Schubert pneumatic process of clarification, and the filtering of the flushing water in the old gate roads. The advantages already suggested, and the increased safety due to the damping of all coal dust in the vicinity of the working faces, would more than counterbalance the extra cost for pumping.

Effect on Health of Miners.—It is frequently argued that to send large volumes of water into the deep warm mines of this country would so saturate the air-currents that the mines would become unhealthy; but one of the great advantages of hydraulic filling is the cooling effect produced, and the consequent general reduction of temperature throughout the mine. In the first place, it does away with the heat caused by the grinding of coal in pillars or coal left in the goaf and the rapid oxidation and heating of the fine coal dust produced by this crushing action of subsiding strata. In the second place, by the cooling effect produced at the working face where packing is in operation; and in the third place, by the cooling effect produced by the increase in the amount of ventilation that reaches the working face.

As the water is led to the goaf in pipes, and may, if necessary, be returned to the shaft in a similar manner, the only place where evaporation can take place to any large extent is at the working face where the goaf is being packed. In many cases the packing is done on the opposite shift to the coal getting, so that the water has had time to drain off before the miners commence work. This and the general reduction of the mine temperature make it possible to use hydraulic packing in the deep and warm mines of Belgium and Germany, where the working day of the miner is longer than is legally permitted in this country.

Packing Very Thin or Very Thick Seams.—In Essen, the Krupp firm are successfully extracting eight coal seams, varying from 20 inches to 5½ feet in thickness, from underneath their engineering works, railways, and large public buildings, through completely packing the excavations with flushed debris.

In Silesia, seams up to 40 feet thick are being worked and completely packed, sometimes by panel slicing the whole thickness of seam and sometimes by longwall layers. Working

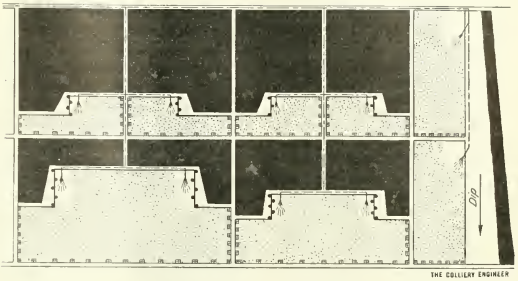


Fig. 7. Longwall and Paneling

is commenced from the bottom upwards, and the goaf is packed in each layer as it is extracted.

The only disadvantage in thin seams, compared with thicker ones, is the frequency with which the flushing pipes have to be moved for a given amount of packing.

In steep thin seams in Belgium, the coal is passed down chutes the height of the seam; or, where the dip is too low for this, conveyers are put in to carry the coal to the loading levels, thus avoiding all ripping of the gate roads where hydraulic stowing is used.

Excessive cost of maintenance of the pipe line was the greatest difficulty that had to be surmounted in hydraulic packing, and it has taken several years of experiment and practice to devise a suitable pipe line capable of resisting the grinding action of the debris in the horizontal pipes. There are practically only four systems now in use, namely, (1) mild ungalvanized steel pipes; (2) mild steel or cast-iron pipes lined with hard wood or steel, Fig. 4; (3) steel pipes lined with porcelain, Fig. 5; and (4) the Stephan system of oval steel pipes, with steel lining, or the Busch system with iron linings, Fig. 6.

The first system is used in many Continental mines, where the plant was installed some years ago, and the second is utilized in Silesia and the Transvaal very successfully, the cost of wooden lining being about 50 cents per yard; but in all new installations the third and fourth systems are adopted.

Porcelain-lined pipes will pass from 180,000 to 200,000 tons of stowing material before requiring renewal, and iron-lined oval pipes will pass 43,000 cubic meters per 1 millimeter (56,245 cubic yards, per .039 inch) wear in pipes. The latter system would seem to be the most satisfactory method yet adopted, and the cost of lining is about $3 per meter.

With the experience of other mining countries as a guide, there ought not to be any doubt regarding the success attending the adoption of an installation on the lines approved by mining engineers where hydraulic packing has been in use for upwards of 20 years.

The difficulty in adapting the system to mines now using hand packing, would be greatest in mines where the working operations are far advanced, particularly in thin seams where the longwall advancing system is in use and the shafts are sunk to the dip of the royalty.

This objection would not apply to newly opened out collieries, nor to most collieries where thick seams are worked either by retreating longwall or bord and pillar, as shown in Fig. 7. The only difficulty in the latter case would be the cost of driving tunnels (or levels in the upper seams) to the rise of the coal, in order to get a sufficient fall for the debris in the pipes.

The advantages claimed for hydraulic packing in Westphalia, according to the report of the British Consul General, are as follows:

1. The increase of the total coal output per annum.

2. The reduction under given circumstances in the consumption of pit timber.

3. The effective prevention of underground gob fires and the great dangers connected therewith.

4. The favorable action against the dangers of firedamp, as all spaces in, or in direct communication with, the goaf are filled.

5. The possibility of winning coal out of lower seams without injuriously affecting those above, and the consequently increased elasticity as to the disposition of work.

6. The remarkable much-needed power of concentration of the work, the increase of powers of production, the reduction of forewinning operations, and the facilities of bringing a new winning rapidly into full production.

7. The reduction of losses in working the broken, the saving to the nation of enormous quantities of mineral wealth, the winning of deposits which were formerly lost, having to be left as pillars.

8. A thorough securing of the surface against damage through good execution of work.

9. A reduction to a minimum of the danger of life and limb in the falling of stone and coal.

10. The great advantage of the system is that it brings with it no new dangers, and that it obviates many dangers and accidents.

Hydraulic filling, which shows so many advantages, is neither bound to special kinds of minerals nor methods of working. While there is no doubt that in its application some difficulty or other may have to be overcome, these will gradually disappear with extended experience. From the technical point of view, there is nothing to prevent its application in many of our large collieries, particularly in thick seams.

West Virginia's Compensation Act

West Virginia's new Public Service Commission reports that 302 coal mining companies, employing 62,546 men, which is more than three-fourths of the total number of coal mine employes in the state, with monthly payrolls aggregating $3,293,303, have already filed notice of their intention to take advantage of the workmen's compensation law, enacted at the last session of the legislature. This law was framed with the idea of affording workmen in all industries absolutely reliable life and accident insurance at the lowest possible cost. The fact that the coal operators worked hard for this law and that they have been so prompt to put its provisions into effect, indicates a practical interest in the welfare of their employes.

Any miner employed by a company that has taken advantage of the law, who is injured after October 1, is now sure that he and his family will be provided for. The state will collect the money and turn it over to the beneficiary with the least possible trouble and delay and at the lowest possible expense. If the miner dies, his family is certain to get the death benefit without quibble or evasion. The state attends to everything.

Under the law, the Public Service Commission fixes a rate of assessment on employers, not to exceed $1 for each $100 of the pay roll. The employer pays 90 per cent., the employe 10 per cent., of this assessment. In case of injury the employe receives half pay, but not more than $8 or less than $4 a week while unable to work, and not more than $150 for medical, nurse, and hospital services. If he is killed, the state pays his funeral expenses, not exceeding $75, out of the fund. In addition, his widow gets a pension of $20 a month until she dies or marries again, while each child gets $5 a month until it attains the age at which it can be lawfully employed. If there is no widow nor child under age, other dependents may receive not more than $20 a month for 6 years. Benefits are made exempt from all claims of creditors and from any attachment or execution.

Unusual Accident

Sometime ago at the Fort Lick mine, in Mingo County, W. Va., a singular accident occurred. A mine car about to start up the outside incline from track to tipple, carried 11 men, although there was supposed to be a rule against men riding up or down the incline. Ordinarily an empty car is hauled up by a loaded car coming down, but on this occasion several loaded cars started down the incline at once, causing the carload of men to go up the ascent at terrific speed.

One man was enabled to jump before the speed became too great, but ten remained on board and when the top of the incline was reached, the car with its human freight went through the roof of the head-house. The mountain has a cone-like apex and the car was thrown down the further side, a distance of about 200 feet. None of the men on the car survived the accident. To avoid an accident of this description and save the men a hard walk up the hill, the Paint Creek Co. is installing an electric hoist at Mucklow, W. Va.

The Standard Chemical Co., of Pittsburg, has 1,100 acres of land containing carnotite, from which, in the course of time, they expect to obtain 6 pounds of radium. The production is 1 grain per month, and its value $120,000 per grain.

Mine Humidification

Method of Supplying Preheated and Humidified Ventilating Air From Evaporative Condenser

By Dwight Gerber*

THE important part coal dust plays in the propagation of an explosion, through the various workings of a mine, has been successively asserted and denied.

It is only in recent years that the necessary study and governmental investigations have been applied to the subject, from which to draw conclusions that would arouse general interest among mine operators.

Such data as have been derived from these studies are fully set forth in Bulletin No. 425, issued by the Geological Survey.

The intent of this article will be to describe a method of supplying a mine with a preheated and humidified ventilating air, suggested by the operation and tests of an evaporative condenser installed at the central power plant of a group of mines near Pittsburg, to handle the exhaust steam from turbine generators.

The suggestion is made in contradistinction to the steam jet and steam coil heating method, described in the Bulletin mentioned.

Next to gas, by far the greatest menace to coal-mine operations is the fine dust generated at working places and distributed through rooms by the ventilating current. This dust is constantly added to by the fine coal that is spilled along haulageways, through openings in cars, where it is pulverized by the traffic of men and mules. Whatever moisture the dust may contain is absorbed by the ventilating current, and then the dust is taken up and carried by the current to be later deposited along the walls of entries.

It is in this condition (upper dust) that dust is most susceptible of explosion.

The difficulty of imparting a sufficient amount of moisture to dust to render it inert, as well as the amount required to produce any deadening effect on a flame being propagated through it, is fully dealt with in the aforementioned Bulletin.

*Mining Engineer, Pittsburg, Pa.

The condenser referred to for the purpose of humidifying air, consists of a nest of 900 vertical, 1½-inch diameter copper tubes, 19 feet long, fixed top and bottom in suitable headers. The tubes are housed in on two sides, as shown in Fig. 1, one side being left open for the admission of air, which is drawn in and around the tubes, by a fan placed opposite the open side.

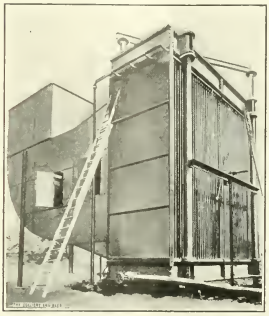


Fig. 1. Arrangement of Tubes and Sprinkler

The vapor generated by the evaporation of water, with which the tubes are mechanically wetted, is picked up by the air as it passes around the tubes and is discharged through an upward extending funnel to the atmosphere.

Where the arrangment of a mine's power equipment will permit, it is suggested that the usual mine fan be made to perform the double service of drawing the air around condenser tubes, where it takes on heat and moisture in proportion to the work of condensation, while on its course to the mine.

By test performance, the amount of water evaporated per pound of steam condensed is approximately 1 pound.

Figs. 2 and 3 will indicate the arrangement of the connections to a condenser, fan, and mine, when blowing or exhausting.

Many variations of the condenser as described could be used for the suggested purpose, but the evaporative kind seems especially adapted, inasmuch as the air required to maintain its efficiency obtains its heat and humidity in a single operation.

It is conceded that cold air must be heated and have a sufficient amount of moisture given to it, to prevent it absorbing moisture from the coal in the mine, as it gradually becomes heated during its passage through the air-courses, thereby increasing its moisture-carrying capacity.

The assumption is made that, if the air supplied to a mine be heated to the mine's normal temperature, and it possesses a relative humidity, it will issue from that mine having practically the same temperature and humidity.

It is further assumed that, should it be possible to sufficiently heat and humidify the required amount of ventilating air, somewhat in excess of the mine's normal temperature, and give it a proportional burden of humidity, an amount of moisture would be given off by the air, as its temperature is adjusting itself to that of the mine.

The basis for the last assumption lies in the nil effect that any quantity of heat given off by the ventilating air, so treated, would have toward raising the normal temperature of a mine.

However, any interchange of heat that might take place, from air to the walls of a mine, would tend to diminish the moisture-carrying capacity of the air, and would result in the deposit of an amount of moisture.

Just what this deposit would amount to, is a question that probably only a test would show.

The possibility of conditioning sufficient ventilating air, and the amount of exhaust steam required to perform the work, can be judged from the result of a series of problems, the results of which are displayed

graphically by means of curves shown in Figs. 4 and 5.

As the result of having all the air entering a mine in a condition in which it would not absorb moisture, its ability to resist the propagation of a flame would be assured.

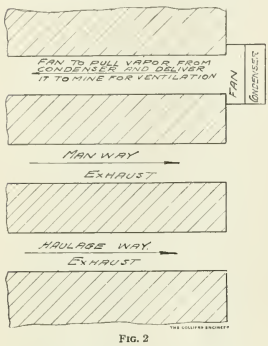


Fig. 2

By virtue of such a condenser, the air used as a vehicle to carry off the vapor, equal to the amount of water placed on the tubes necessary to effect condensation within the tubes, produces in one operation a pre-heated and humidified atmosphere.

It seems possible to adjust the degree of heat and humidity imparted to air passing through such a condenser to such a degree that the comfort of the miner would in no way be affected. By so doing, however, it might be necessary to forego some inches of vacuum in order to maintain the adjustment.

Where a sufficient horsepower of exhaust steam is not at hand, the amount of coal required under a boiler, working at 60-per-cent. efficiency, to produce low-pressure steam used in coils to heat air, is approximately $6\frac{1}{2}$ tons per 24 hours, for a unit of 100,000 cubic feet of ventilating air per minute.

In such an arrangement, it must be understood that the air is humidified by a second operation in exposing the heated air to water in a finely divided state.

From a hygienic standpoint, mine ventilating air treated in the manner described would, to a considerable extent, bring about the same results that are claimed for devices now being used to condition air used to ventilate public buildings, assembly halls, and many up-to-date residences.

The advantages claimed for such devices are threefold:

First. That the washing operation will throw down any germ carrying dust, and remove and neutralize oils, gases, and odors.

Second. By maintaining a natural relative humidity, the air will not attract moisture from any object it may come in contact with.

Third. The influence moisture contained by the air has in maintaining plant life.

The designs of such controlling devices are based on the property air has of retaining heat in proportion to its relative humidity.

That is, if air be heated, it must take on at the same time additional moisture to absorb it; otherwise, it simply passes through the air and is lost.

Consider air at 20° F. containing .0148 gallon of water per 1,000 cubic feet, having a relative humidity of 70 per cent. to be heated to 70° F.; without the addition of any moisture, the relative humidity would fall to 10.8 per cent., which would be quite low, considering the average humidity of about 70 per cent. for this climate.

The analogy of the two propositions lies in imparting heat and humidity to the air in a single operation, thus insuring a high relative humidity.

Considering the many factors entering into the successful operation of such an air-tempered device, when adapted to the general mine proposition, along with the comparative subtile laws governing the conduct of air, it is quite difficult to draw definite conclusions; however, the foregoing matter possesses sufficient merit to warrant consideration of mine operators.

The following calculations on assumed conditions, enter into the construction of the curves in Figs. 4 and 5.

ASSUMED CONDITIONS

Atmosphere at 20° F., heated to 85° F., and used to ventilate a mine having an average temperature of 60° F.

Vapor pressure at 85° F. = .591. Heat evaporation at 85° F. = 1,054.8; 14.7 − .591 = 14.109; 461 + 85 = 546.

From F. W. Wright, "Design of Condenser Plant": Weight of 1 cubic foot of dry air at a pressure of 14.7 pounds per square inch at 32° F. = .0809, and occupies $\frac{1}{W} = \frac{1}{.0809}$ = 12.37 cubic feet; under any other condition its volume is represented by formula $PV = RT$, in which P, is the pressure in pounds per square foot, V = volume, T = absolute temperature, R = constant 53.18 for air and 85.5 for water.

Let ∂ represent the density. ∂a = air, ∂w = water, $\partial a = 2.708 \frac{14.109}{546}$ = .069977; $\partial w = 1.684 = \frac{.591}{546} = .0018228$.

$\frac{.0018228}{.069977} = .02604$ pound of water in 1 pound of vapor.

$\frac{.069977}{.0717998} = .9746$ pound of air in 1 pound of vapor.

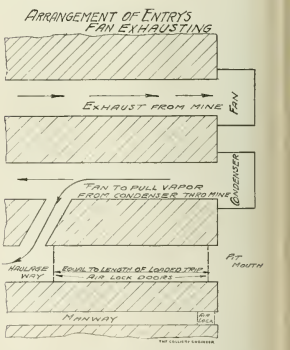


Fig. 3

.06977 + .0018228 = .0717998 = wt. of 1 cu. ft. of vapor.

$\frac{1}{.0717998} = 13.92$ = volume.

.0717998 × 1,000 = 71.7998 = wt. 1,000 cu. ft. vapor.

$71.7998 \times .9746 = 69.9763$ = wt. 1,000 cu. ft. dry air.

$85-20=65$. $65 \times .23 = 14.95$ B. T. U. in air.

$1{,}054.8 \times .026048 = 27.4754$ B. T. U. in water.

$14.95 + 27.4754 = 42.4254$ B. T. U. in vapor.

Amount of steam available from 100 horsepower fan engine using 30 pounds of water.

$\frac{100 \times 30}{60} = 50$ lb. steam per min.

$\frac{50}{2.7846} = 17.956 \times 1{,}000 = 17{,}956$ =cu. ft. of vapor. Conditioned by 100 horsepower of exhaust steam.

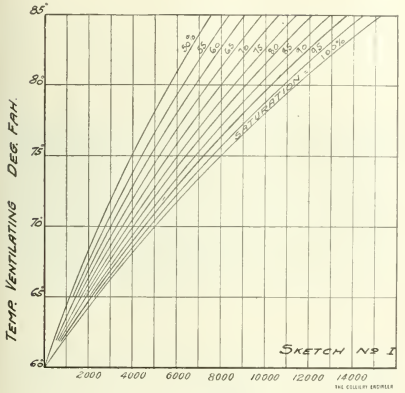
exhaust steam required to condition 100,000 cu. ft. of vapor.

Water in 1 cu. ft. air at 85° F. ..... = .026040 lb.

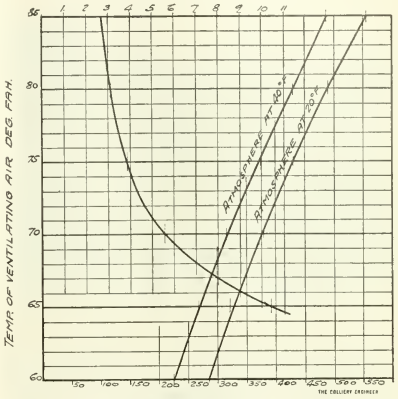
Water in 1 cu. ft. air at 60° F. ..... = .010956 lb.

Water laid down by 1 cu. ft. air ..... = .015084 lb.

$.015084 \times .06997 \times 100{,}000 \times 60$



Pounds of Water Deposited in 24 Hours for each Unit of 100,000 cu. ft. of Ventilating Air


POUNDS OF STEAM CONDENSED PER POUND OF WATER DEPOSITED.
TEMP. OF VENTILATING AIR DEG. FAH.
ATMOSPHERE AT 40°
ATMOSPHERE AT 20°
THE COLLIERY ENGINEER

Horsepower of Exhaust Steam Required to Condition Each Unit of 100,000 cu. ft. of Mine Air

FIG. 5

$69.9763 \times 42.4254 = 2971.1936$ B. T. U. required to condition 1,000 cubic feet of vapor.

Exhaust steam at 2 pounds pressure. $T = 126°$ F. $126-85=41$ $+1{,}026=1{,}067$.

$\frac{2{,}971.1936}{1{,}067} = 2.7846$ pounds of exhaust steam per 1,000 cu. ft. of vapor.

$\frac{2.7846}{1{,}000} = .0027846$ lb. of steam condensed per cu. ft. of vapor.

$.0027846 \times 100{,}000 = 278.46$ lb. of exhaust steam required to condition 100,000 cu. ft. of vapor.

$\frac{278.46 \times 60}{30} = 556.92$ horsepower of $\times 24 = 15{,}198$ lb. of water absorbed in mine, by a unit of 100,000 cu. ft. of ventilating air in a period of 24 hours.

$\frac{42.46}{.010584} = 2{,}814$ B. T. U. per pound of air.

$\frac{2{,}814}{1{,}067} = 2.637$ lb. of steam condensed per pound of water absorbed.

Recapitulation of Data

Vapor					Weight of				Volume	B. T. U. Reqd. to Condition 1,000 Cubic Feet Vapor	Pounds of Steam Condensed Per 1,000 Cubic Feet Vapor	Cubic Feet of Vapor Conditioned by 100 Horsepower of Exhaust Steam	Horsepower of Exhaust Steam Required to Condition 100,000 Cubic Feet	Pounds of H_2O Deposited by 1 Cubic Foot of Vapor	Pounds of H_2O Deposited by 100,000 Cubic Feet Vapor in 24 Hours	B. T. U. in 1 Pound of Dry Air	Steam Condensed per Pound of Water Deposited
Temperature of	Pressure	Absolute Temperature	δa	δw	Air in 1 Cubic Foot of Vapor	H_2O in 1 Cubic Foot of Vapor	1,000 Cubic Feet Vapor	1,000 Cubic Feet Air									
85	.591	546	.0699	.0018	.9746	.0260	71.79	69.97	13.92	2,917.1	2.780	17,956	557.0	.0150	15,198.0	2,814.0	2.63
80	.502	541	.0710	.0015	.9784	.0220	72.62	71.05	13.76	2,636.9	2.450	20,292	491.8	.0110	11,322.0	3,353.0	3.12
75	.426	536	.0721	.0013	.9817	.0185	73.45	72.12	13.61	2,333.8	2.160	23,073	433.4	.0076	7,904.0	4,251.0	3.94
70	.360	531	.0731	.0011	.9846	.0156	74.27	73.12	13.46	2,057.1	1.901	27,351	380.2	.0046	4,907.2	6,031.0	5.57
65	.303	526	.0741	.0009	.9870	.0131	75.09	74.11	13.31	1,804.7	1.660	30,114	332.0	.0021	2,284.0	1,135.2	10.44
60	.254	521	.0750	.0008	.9891	.0109	75.90	75.09	13.17	1,572.5	1.430	34,500	287.8				

Strip-Pit Mining in Kansas

By Barry Scobee

Open-cut, or strip-pit, mining, as followed in the shallow-coal field around Pittsburg, in southeastern Kansas, has brought about developments peculiarly its own. One of the latest is the method of lifting the coal from the pit with a crane instead of drawing it up an incline as formerly, and, in fact, as is practiced yet in most of the pits.

This plan, having no track in the bottom, eliminates the motor car and the mules. The crane is set at the very edge of the pit and is moved by its own power so that it keeps along even with the miners in the cut below. Thus the coal always is reached without difficulty.

Six or seven 5-ton car bodies are kept in the pit, and these are lifted out by the crane, as shown in Fig. 1, which swings and deposits them on the running gears of tram cars, as shown in Fig. 2. These cars then are hauled by a mine locomotive to a tipple, where a derrick elevates the car bodies and dumps them into the tipple, as shown in Fig. 3. The coal usually is screened.

The coal is loaded into the car bodies by hand. As many men as can work without crowding keep pretty well up with the shovel which uncovers the coal. The coal is shot at intervals of about 6 feet by putting the black powder charges in from the top, and not from the face, of the bed. Shooting is much cheaper and more practicable than any other method of breaking the coal.

The use of a small steam shovel to put the coal into the skips has been considered, but "horsebacks" are too numerous to make one practicable, it is claimed. In shoveling by hand these can be avoided. The hand filling of car bodies is not difficult, as the shot breaks the coal up quite fine and there is good bottom usually. The car bodies are set at the very spot where the men work, and the coal never is carried. The loaders do not step from their tracks, as shown in Fig. 4.

The method was brought into use by Mr. Edward Packard of the Packard-McWilliams Co. Much is claimed in its favor. For one thing it is speedier; the digging of a ditch in the coal in which to lay a pit track is done away with, and that process, since the coal is 3 feet thick and had to be shot at frequent intervals, was long and comparatively costly.

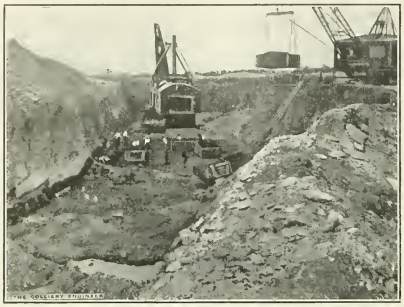


Fig. 1. Hoisting Coal with Crane

Fig. 2. Placing Loaded Car Bodies on Running Gear

Fig. 3. Delivering Coal to Tipple

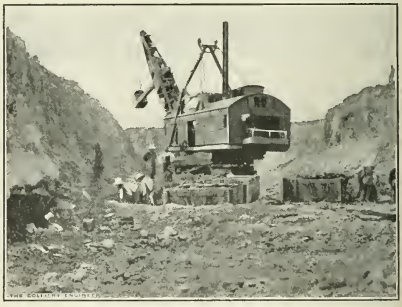


Fig. 4. Loading the Car Bodies

Horsebacks also form less of an obstacle by the crane method than by the other way.

The track on the surface for the locomotive to the tipple can be laid well the first time and then merely slipped back as the pit edge encroaches on it. Only occasionally does it need to be broken for lengthening or shortening.

About the only objection to the method is the cost of installation, which includes at least the crane at the pit side more than the old method, and most of the time would include the locomotive. The reason for this is that not a locomotive but a mule is used to move the coal to the railway. However, a stationary engine nearly always is used to draw the pit cars to the surface by cable up an incline. Most operators, however, claim that the system is too costly. These are the ones who have not used it. The Packard-McWilliams Co. claims that enough more coal is taken out to pay the extra cost.

The Packard-McWilliams pit varies in depth from 18 to 27 feet. The average production per day is 30 tons, and it is claimed that this company has covered more ground in its 14 months of operation than any other, the extent being 10 acres. Conditions have been favorable. One measured acre produced 5,600 tons. No definite figures on cost of production per ton have been deduced, owing to the complicated nature of the work, but it is figured that this method is somewhat cheaper than the old, by which the cost of removing earth is between 5 and 6 cents a cubic yard, according to the depth and nature of the covering.

34-4-5

Miner Entombed for Eight Days

A peculiar experience was afforded a Polish miner, working for the Lehigh Valley Coal Co., at the Continental mine, near Centralia, Pa., several weeks ago.

On Friday morning, September 26, John Tomaschefski fired a shot at the face of Breast No. 5, Mammoth Seam gangway off No. 3 tunnel. At the time of firing, he with his "buddy" were in the gangway below. The shot was fired about 10 o'clock, and a few minutes later Tomaschefski started up to the face of the breast alone. The roof was decidedly weak about half way up the chamber, and it caved, imprisoning the miner.

The work of reopening was started immediately, the nature of the debris necessitating forepoling. On Sunday morning, 2 days later, the rescuing party opened a hole through to the place where Tomaschefski was, but he refused to come down from the face, being afraid that the roof, which was cracking at the time, would fall and kill him. While debating the question with him for about 10 minutes, the pillar on the left ran, completely closing up the breast. The men worked until that night, then gave up the attempt to reach him from that part of the mine.

The next step undertaken was by going down the big mine breach, shown in Fig. 1, and through the old workings to the pillar adjoining Tomaschefski's place on the east, and there starting a diamond drill hole toward the entombed man. The hole was finished Tuesday and a 2-inch pipe forced through. The hole was 48.7 feet long, and dipped 1 degree and 50 minutes toward breast No. 5. It was then that food was sent in to the miner, who had been without anything to eat since Friday morning. This they were enabled to do by forcing a small rope through and then tying the end to a tin tube having a screw top, as shown in Fig. 1. Later the miner complained of being cold, so an army blanket was torn in half lengthwise, forming two pieces 3 feet wide and 12 feet long. These were rolled tight diagonally, so as to give the greatest possible length, then greased and sent through, in the same manner as the feeding tube. In like fashion several pairs of socks and a suit of underwear were sent through to the entombed man.

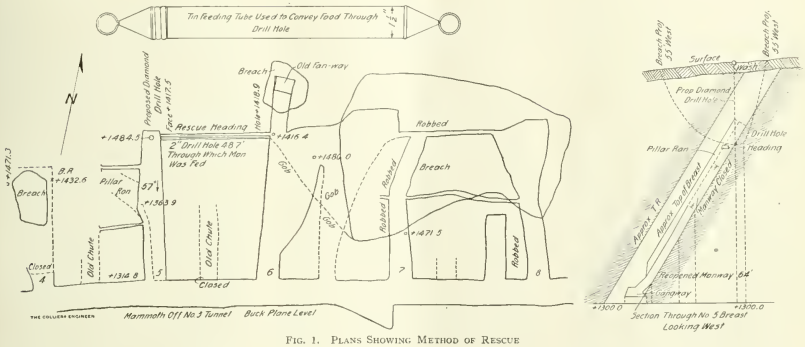


Fig. 1. Plans Showing Method of Rescue

Later he complained of being in a wet place, so a coil of 1½-inch transmission rope was passed through the pipe, which he coiled up in the form of a mat.

The space in which he was confined was 7 feet wide at the bottom, narrowing off to a point at the face 15 feet above.

The coal in the pillar through which the rescuers then attempted to reach Tomaschefski is extremely hard, and it was found necessary to erect a temporary blacksmith shop, as all the work had to be done by hand, and a few minutes' work would dull a pick. In order to expedite the work, the company decided to use air drills. An air compressor and a gasoline engine were taken to the scene, but it was found impossible to anchor the engine, owing to the poor soil and strata, so that method was abandoned. A heading was then started about 4 feet wide and about 4 feet high. One man was able to pick at a time, and had two men shoveling for him. The men worked three shifts of 8 hours each, six men and a foreman to each shift. The heading followed the drill hole all the way through the pillar.

On Saturday morning, October 4, at 7 o'clock, the heading broke in through breast No. 5, and Tomaschefski was rescued, after having been imprisoned for 7 days and 21 hours.

When Tomaschefski reached the surface, he declared his intention of going back to work as soon as he had had some sleep, but owing to the newspapers keeping him in the spotlight for 8 days, he accepted an offer of a 6-weeks' contract in a cheap vaudeville circuit at $15 a night.

The company found it necessary to construct a road to get the diamond drilling machine to the scene. An emergency hospital was erected on the surface at the breach, as well as an office and temporary quarters for the rescuers. Telephonic communication was made with the Continental shaft a mile distant. Superintendent H. J. Heffner, was in charge of the work during the entire time, and was ably assisted by James A. O'Donnell, mine inspector of that district.

The Cementation Process for Sinking Shafts

*By Sydney F. Walker**

The cementation process is employed where the quantity of water running into the shaft is difficult to keep down with a pump. It is a question also, whether, when a shaft is to be sunk in ground that is known to be faulty, and in which, therefore, water may be expected to rush in through fissures at any moment, it may not be wise to protect the sinking at the commencement by the adoption of the cementation process. As mining engineers know, the water which troubles them in their shafts and in their workings, very often runs in from water bearing strata, through fissures in non-water bearing strata. Water bearing strata are often faulty, and where the edge of the water bearing side of the fault meets a fissure in the non-water bearing strata the water runs through the fissure into any space, such as a well, that may be provided for it. For practical purposes, a shaft is similar to a well; and in the course of sinking, fissures leading from water bearing strata are often struck, with the result that enormous quantities of water are poured into the shaft at short notice.

The plan involved in the cementation process is, to fill all the fissures through which water can run into the excavations; practically to dam back the water. According to the experience in the United Kingdom, the process is successful, except in certain cases; and it appears that in those cases the freezing process would be even more difficult to carry out.

In carrying out the cementation process, a ring of bore holes is put down in the strata through which the shaft is being sunk, and 3-inch pipes are driven into them. In one shaft, which was 25 feet in diameter, eight bore holes were put down on the inside, the diameter of the ring of bore holes being about 20 feet. The bore holes are first put down to a depth of 9 feet, then 15 feet of 3-inch casing is forced into each hole, so that the pipe stands above the ground to a distance of 6 feet. The diamond drill is then set to work inside of the casing pipes. The diamond drill had a crown 1½ inches in diameter, which gave a core of ⅜ inch. The boring is continued until a fissure containing water is met, and it is known when this occurs by the water issuing from the top of the 3-inch pipe. The water is usually under pressure, sometimes being forced up by the pressure of gas, as well as by the pressure of the water in the water bearing strata. As soon as water appears the boring is discontinued, the drill removed, and a pressure pump connected to the 3-inch pipe. Liquid cement is forced by the pump down the pipe, down the bore hole, and into the fissure under a pressure of from 800 pounds to 1,200 pounds per square inch; the idea being to force it into the fissure and to fill it completely. When no more cement can be forced in, the top of the 3-inch pipe is plugged and allowed to remain undisturbed for about 30 hours. At the end of that time the plug is removed from the pipe and the cement is drilled down to the fissure, then if no water appears the drilling is continued until another fissure is struck, when the process is repeated. If water appears on drilling out the bore hole, the process is repeated until the fissure is completely closed by cement. The same process is going on at each of the bore holes, and when a depth of 150 to 250 feet has been reached by this method, rock sinking is commenced and carried to the same depth. Care is taken to make quite sure that no water appears at any of the 3-inch pipes before sinking is commenced; also, they are carefully watched while the sinking proceeds, and if water appears at any one of them, the process of forcing cement into the bore holes is again repeated. After the shaft is sunk and the walling* is put in, the stopping back

*Bloomfield Crescent, Bath, Eng.

*In Great Britain shafts are made of circular cross-section and lined with masonry.

of the water is further ensured by drilling holes at the depths at which fissures were met with, horizontally into the strata behind the walling, and forcing cement in under pressure in the same manner as was done from the surface. Cement is also forced in behind the walling at various points where it is thought desirable, or where there is any appearance of water. The horizontal bore holes that are drilled for supplementary cementing are carefully plugged up when everything appears right. After the walling is completed for the 150 feet or 200 feet that has then been protected and after the supplementary cementation has been completed, bore holes are drilled down from the bottom of the shaft, and the process repeated in the same manner as from the surface. In this way, any reasonable depth of sinking can be carried out.

As in every other process, headwork is required in carrying it out to meet the varying conditions. The thickness of the cement mixture requires very careful consideration. If the fissure is wide the cement mixture may be a fairly coarse sandy grout; while if the fissure is a narrow one, it will be better to employ the much thinner neat cement stream. Again, dealing with each individual fissure requires a considerable amount of skill in determining the density of the cement. The fissure may be wide where the bore hole strikes it, and may work back into narrower passages. In such a case possibly a thinner fluid will be best to employ at first, this being followed by a denser fluid, when apparently the smaller passages and their ramifications are filled up. As mining engineers know, fissures are usually very irregular, and there may be branches of various widths, and again the branches themselves may be of various widths at different parts. All of these things have to be taken into consideration, and the man who is working the hydraulic pump and who is responsible for the mixing of the cement, will be guided by his experience in adapting the density of the cement to the conditions present. The working of the pump itself will probably tell him almost all that he wants to know once he has some experience in working the process.

A great deal also depends upon the quality of the materials used in making the cement, and as every engineer knows, probably as many failures are due to bad materials as to bad design. The cementation process depends on a liquid cement that will flow freely and find its way into every crevice through which water can pass, and set solidly afterwards. Cement that will not flow freely or that is acted upon by any of the salts that may be contained in the underground water may render the use of the process unadvisable.

The cases where it is difficult to apply the cementation process are where drilling is difficult. In one case where the strata near the surface for some considerable distance were easily drilled, at a certain distance above where water was to be found, very hard boulders were met which it was exceedingly difficult to drill through. In such a case sinking might be carried on in the ordinary way until the water bearing stratum was met with, passing through the hard boulder formation, and then the fissures might be filled with cement by horizontal bore holes.

At a sinking operation in South Wales this plan was adopted, not because of the presence of the hard formation, but because the owner of the colliery chose to adopt that method in place of drilling holes from above and protecting the sinking in the way mentioned. In this case, sinking proceeded in the usual way until there was a serious inflow of water. Then the cementation process was brought into operation by drilling horizontal bore holes very slightly above where the inrush took place, directing the bore holes down toward where the fissures would appear to be, and forcing cement into them. It is, of course, an open question which is the best method. The method first described in this article is the more scientific.

Miners' Vocational Schools

Two years ago Nathan C. Schaffer, Superintendent of Public Instruction in Pennsylvania, visited the Nanticoke District Mining Institute on the opening night. He was surprised to see about 500 members present to take part in the opening exercises, and then and there promised that he would try to obtain a suitable appropriation to help vocational schools of this kind.

Evidently so soon as the next legislature met he had introduced a Bill to provide for vocational schools, for An Act, No. 92, was passed May 1, 1913, to conform with his plans, and later an appropriation of $140,000 was made to cover in part the expenses connected with vocational schools. This act defines vocational education as "any education the controlling purpose of which is to fit for profitable employment."

The State Superintendent of Public Instruction is the executive officer of the State Board of Education, and any school district through its board of school directors may establish a vocational school, or two or more districts may combine. Local school boards and joint school committees administering approved vocational schools may appoint an advisory committee representing local industries whose duty it shall be to advise with the local or joint school directors and other school officials.

The Commonwealth in order to aid in the maintenance of approved local or joint vocational schools, will pay annually from the treasury to school districts maintaining such schools two-thirds of the sum which has been expended during the previous school year for instruction in technical subjects: Provided, No one school district shall receive more than $5,000 in any one school year.

The schools at Nanticoke, where the Susquehanna Coal Co., the Delaware, Lackawanna & Western Railroad Co., and the Lehigh & Wilkes-Barre Coal Co. have operations, and

at Shamokin, where the Lehigh Valley Coal Co., the Mineral Railroad and Mining Co., and the Philadelphia & Reading Coal and Iron Co., have operations, have been growing. The number of classes has more than quadrupled.

The third annual report of the Nanticoke district institute and classes shows a membership of 697 for the former and eight meetings with an average attendance of 199. The classes had only two dozen students in 1910, but increased to 657 in 1912. At the examination for Mine Foremen's and Assistant Mine Foremen's certificates, held in Nanticoke last March, four members of this school passed the state examinations for the former, and 24 members passed the state examinations for the latter.

The third annual report of the Shamokin-Mount Carmel district institute and classes shows a membership of 571 for the former and seven meetings with an average attendance of 127. There were 450 men at the first banquet at which Morris Williams, President of the Susquehanna Coal Co. presided and spoke. The classes had 25 students in 1910, 56 in 1911, and increased to 763 last year. At the examinations for Mine Foremen's and Assistant Mine Foremen's certificates held at Pottsville last March, members of this school secured two of the former and six of the latter.

The classes at both Nanticoke and Shamokin are held in the local school houses in the evening from October to March each year. It is aimed to locate them as centrally as possible and to hold them three nights a week so that as great a percentage as possible of those enrolled can attend regularly. No trouble is anticipated in conforming to the state requirements, especially as it will lend its supervision next year, and it was the school boards in these districts who conducted these schools last year and fostered and gave its present impetus to the whole movement.

The good accomplished by these institutes and schools, together with the efforts of the Y. M. C. A., the International Correspondence Schools, and the mine schools of the Lehigh Valley Coal Co., the Philadelphia & Reading Coal and Iron Co., the Delaware, Lackawanna & Western Coal Co., and the Pennsylvania Coal Co., is shown not only by the number of state certificates granted to the students, but by a constant leavening of all ranks of mine workers through promotion. Many of the highest officials in the anthracite companies started out as mine workers, breaker boys, or in minor positions in the offices and they have not forgotten their early experience and the difficulties they encountered in getting their technical educations, and had it not been for the International Correspondence Schools, some would never have obtained them.

New Mine Safety Sign

James E. Roderick, Chief of the Department of Mines of Pennsylvania, has just issued an order to all the State Mine Inspectors, requiring them to enforce the posting of a new mine safety sign in all the coal mines of Pennsylvania.

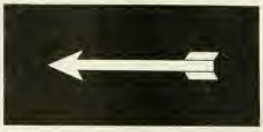


Fig. 1

This sign was designed by Mr. Roderick, as a means of preventing mine workers becoming lost in the mine workings and as a guide to quick exit in case of accident.

The design of the sign is shown in Fig. 1. It is to be made of wood or metal, with a white arrow on a black background. In size it is to be 15 inches long by 7 inches wide. The signs are to be put up along all roads where workers are likely to travel; the arrow pointing the way to the nearest exit, whether it be the principal mine mouth, a man shaft, or traveling way.

Recently a number of mine workers, generally illiterate foreigners, have been lost in the mine workings for days at a time, and Mr. Roderick's idea is to prevent this by a sign which can be understood by men who are unable to read lettered directions.

Safety First

*By Thomas Moses**

Before "Safety First" really means anything, the employer must sincerely and honestly believe in it. If he, as many do, paints it on his property in big signs, places it on his stationery in bright letters, speaks of it in public gatherings such as this, and does nothing more, the words are detrimental to the results desired; but if he sincerely believes in decreasing accidents, makes safety first his religion, and under no circumstances deviates from its meaning, he will obtain profits from its teachings.

"Safety first" does not eliminate all the dangers in coal mining; it only minimizes them. Accidents in coal mining cannot be entirely stopped, but the dangers should be decreased. To obtain this result something must be sacrificed temporarily. First, your superintendent and bosses will be sceptical, and doubt your sincerity, but before you can make any progress you must convert them. They, in turn, must conduct a vigorous campaign until every employe is satisfied that you and your officials are in earnest, then results begin to appear. You must take your employes into your confidence and avoid all insincerity, regardless of results, to keep inviolate the slogan "safety first."

It may be hard when markets are good and there is a profit in the business and you are anxious for an output, to discover some broken bars, loose rock, accumulation of gas, bad track, or any one of the numerous dangers that a coal mine is heir to, and then stop operations until things are made safe. Yet, you must do it, for you are a convert to "safety first."

*Superintendent, Bunsen Coal Co., Westville, Ill. Read at dedication of the University of Illinois Mining Laboratory.

When an accident happens you must investigate with an open mind free from selfish desires, and find out exactly what was the cause, then make sure the cause is removed in all parts of the mine, so that the same kind of an accident cannot happen again. When the mine inspector visits your mine do not speed up your fan, do not send special men to keep your doors shut and operate your regulators so a larger amount of air is in the section he is in, than is ordinarily there, as you do not gain anything in trying to fool him. You usually, by such practice, fool yourself, and if you will spend as much time and energy in obeying his recommendations as is necessary to exert to give him a false impression of your conditions, you will accomplish much toward getting results from "safety first." It is often said that the lack of discipline prevents reforms in coal mines; that the miner will not do what the operator tells him for his own safety, and it is to be regretted that this is, in a few cases, true, but it can be, and has, in many cases been overcome. To bring discipline to a large mine, it is necessary to discipline the operator first, set the example of obeying the inspector. When you do not comply with the law in some matter, and your attention is called to it, do not offer excuses or become angry at the inspector, but show the right spirit, get the wrong righted, and remember the slogan, "safety first."

When you show this attitude to your subordinates, you will find less trouble in getting them to follow your example, and you have laid the foundation for getting results from "safety first."

The real work must be performed by the men who attend to details, the mine manager, the assistant mine manager, and mine examiners or fire bosses, and the workmen in all kinds of work in the mine. When the mine boss or examiner finds a man working in a dangerous place, or performing any dangerous practice, he should stop him and give him instructions how to make himself safe to accomplish the result he desires. Sometimes, especially old miners, resent being criticized in their method of work and are not slow in telling the boss how long they have worked in mines and how much they know, and will in every manner discredit and discourage the boss who is trying to make them safe, or at least lessen the dangers of their occupation. This kind of a miner should be discharged at once, and the boss should not hesitate to do it, as it is only a question of time until that man will get injured or killed.

If this is done fairly and entirely in the interest of "safety first," without malice on the part of the management toward its employes, I think great results can be gained through a campaign of "safety first."

How much does "safety first" cost, and does it pay? is often asked by men interested in coal mining. I will answer, yes, to the last question and say, to get the exact cost of a "safety-first" campaign will be a very hard task; for instance, when laying track if you lay it to a rule of safety it will cost more money to provide clearance for men to work around the cars where it is necessary, or to pass cars conveniently where that is necessary, and it will be hard to separate the amount of work done in the interest of safety from the total cost of laying the track. The same applies when timbering. If you put up your timbers so as to keep them so the cars cannot strike them or so that men when working around cars have not got to squeeze themselves between a car and a prop, it is hard to separate the part of the work done in the interest of safety from the work that would have been done had it been done in the most slipshod manner possible. The same applies to ventilation and to supervision. To visit each working place as often as is necessary to insure safety would require at least one visit by a competent person just previous to the entrance of the workmen, or as close to that time as is possible, and another visit during the day, by some competent person, to see if everything is safe, and more frequent visits to places where danger is known to exist. Were all this man's time charged to "safety," the cost would be great, but while this man is going from place to place, he not only attends to the duties imposed on him through the rules of safety, but he sees that a greater efficiency is gotten out of the labor employed in the mine; that a greater output is obtained, and that material is better taken care of; so you can readily see that, to separate the time spent in actual safety work from the duties imposed by operations or improvements, the actual cost of safety is hard to determine; but "safety first" requires good air for men to work in, good track to haul coal on, and good equipment, such as cars, locomotives, etc., all of which tend to increase the efficiency of the mine and increase the output, which will lessen the cost per ton for labor necessary to produce coal in the mine; therefore, I can only approximately give the figures of the operating cost to produce coal before and after a campaign for "safety first" has been inaugurated, which campaign included, first, the establishment of good ventilation in all the mines, the laying of good track, the overhauling and placing in first-class condition of all equipment, such as mine cars, locomotives, and other machinery around the mine.

The operator is working under the compensation law of Illinois, paying for accidents as the law prescribes, which I wish to say is a great help in making "safety first" a success. It creates a better feeling between employer and employes and eliminates the desire on the part of employers to twist the facts of an accident so as to make a good defense against liability, or the injured man or his friends from cooking up a case for damages against the employer unjustly. It makes each anxious to find out the real cause of an accident when it happens and find an honest preventative for its recurrence.

The record of the mines referred to for 9 years previous to the inauguration of "safety first" as a motto, was one fatal accident to every 135,827 tons of coal mined. The best 1 year in the 9 years was

one fatal accident to every 188,387 tons of coal mined. During this year, very little coal was mined, less than one-fourth of the amount now produced. The first year of this campaign, one fatal accident occurred to each 132,452 tons of coal mined.

The second year, one fatal accident occurred to every 329,474 tons of coal mined, showing an increase of 192,022 tons of coal mined per fatal accident, and notwithstanding that an increase of 10.8 per cent. in wages during this time, coal costs less per ton now for labor in these mines than it did the year previous to the inauguration of "safety first" as a slogan. During this period, acting under the compensation law of Illinois, it has cost approximately 1½ cents per ton, which charge covers all cost of money spent in teaching first-aid work to employes, ambulance and hospital service to all who needed it, medicine and doctors' services, and salary of person in charge of compensation department, and compensation for all injuries received.

Timely Suggestion

As cold weather draws near, the users of explosives are again confronted with the problem of the safe thawing of dynamite through the winter months. Nearly every one recognizes the danger of toasting before a fire, frying on a boiler, and roasting in an oven, but a number of users of explosives do not yet appreciate the loss incurred in improper methods of thawing which may be perfectly safe. For instance, it is fairly safe to plunge a lot of powder into tepid water, provided that the nitroglycerine which leaks out is taken care of so that it does not explode at some unexpected time, but the loss in efficiency of the dynamite would pay for an efficient thawing apparatus many times over. Any one with a piece of paper and a pencil, can readily figure out what loss of efficiency, say 40-per-cent. dynamite incurs when it is so soaked with water that it will only do the work of a 30-per-cent. dynamite. In addition to this, the hazard of having a quantity of free nitroglycerine around is very great.

Underground Telephone Systems

Not only because of the protection it affords to lives and property but as the means of placing mining business on a more systematic basis, the telephone system, reaching every important part of the mine, and placing the most remote shaft or gallery in instant touch with every other important point, is an indispensable feature of the mine equipment.

Following the Cherry Mine disaster, the legislature of Illinois made compulsory the placing of some such protective measures in mines. The result has been the development of telephones especially for mine work.

In shaft mines the telephones are sometimes connected with wires maintained primarily for other purposes. Such circuits are not insulated. Miners traveling about in the tunnel are able to bridge across the circuit at any point and to give signals from any part of the mine.

A few weeks after a telephone system had been installed in one mine in the Pittsburg district, the telephone was instrumental in checking a serious underground fire. An employe detected the smell of smoke and, running to the nearest telephone, informed the private branch exchange operator at work in a building near the mouth of the mine. The operator called each telephone station in the mine, and men were sent out from all points to search for the blaze. At the same time the superintendent, who was at his home, was notified by telephone.

In this way the fire was reached and extinguished through the timely warning given over the telephone. In another mine a worker fell beneath an electric locomotive, and was badly hurt. Word was at once sent to a surgeon, who was waiting at the entrance to the shaft when the car arrived bearing the injured man. In this case the telephone saved a life.

The telephone has been made a valuable aid to the work of the engineer operating the hauling cables, who is kept informed as to when to apply the tightening mechanism.

Ordinarily, it requires a man half an hour to run, jump, stumble, and walk from the mouth of the mine to the parting in the interior. Aside from the telephone, this is the only method by which urgent messages may be given to the outside world. There were no intermediate steps in the improvement worked in this case by the telephone. It was a single leap from the message-bearer plan adopted by the ancients to the latest and most satisfactory means of communication—the telephone.

Mine Accidents in Great Britain, 1912

Mr. R. A. S. Redmayne, Chief Mine Inspector in Great Britain, issued his report for 1912, in August, 1913, from which are obtained the following data:

Number of tons of coal mined, 260,398,578.

Number of tons mined per employe, 239.

Number killed by accidents, 1,276.

Number killed under 16 years of age, 71.

Number of persons employed at coal mines, 1,089,090.

Number of persons employed underground, 878,759.

Number of persons employed on the surface, 210,331.

Number of females employed (surface), 6,486.

Number of persons under 16 years, employed below ground, 50,447.

Number of persons under 16 years, employed on the surface, 20,596.

Death rate per 1,000 employed, 1.17.

Death rate per 1,000 employed underground, 1.25.

The Ability of the Acetylene Flame

To Show the Presence of Dangerous Gases in Mines—Lack of Oxygen in an Atmosphere Indicated by Change of Color

By E. M. Chance*

IN ORDER to understand the action of acetylene and other flames in the presence of blackdamp and whitedamp, it is necessary that the composition of these gases be understood and their effects on man explained.

Blackdamp is composed principally of nitrogen, oxygen, and carbon dioxide in various proportions. The amount of nitrogen it is unnecessary to take into account. The two important gases are oxygen and carbon dioxide.

In many hundreds of tests of blackdamp which the writer personally made, it was rarely if ever that the writer found the percentage of carbon dioxide to exceed 5. The amount of oxygen in these tests has varied from 18 per cent. to nil.

Many writers have conclusively proven that carbon dioxide in small quantities can be breathed by man for a long time without any injurious effect. In fact, as high as 6 per cent. of carbon dioxide when present in air carrying the usual amount of oxygen, can be breathed for some time without injury. This is because carbon dioxide is not of itself injurious. It may be considered an inert gas and its danger when found in blackdamp is not from the gas itself, but on account of absence of the oxygen which it usually replaces and which is necessary to support life.

In whitedamp, on the other hand, the danger lies in the actual presence of carbon monoxide. This is an actively poisonous gas and a small amount of it will kill, irrespective of the amount of oxygen in the air. Herman has shown that 1 per cent. of carbon monoxide in the air will kill a man after breathing it for a few minutes. He also shows that .2 per cent. will cause death in the course of half an hour.

It will, therefore, be readily seen that the danger in blackdamp lies in the absence of sufficient oxygen to support life. In whitedamp, it is the deadly gas itself, irrespective of the amount of oxygen present.

It is therefore evident that where a normal amount of oxygen is mixed with carbon dioxide, a man can breathe large quantities without injurious effects. The danger in blackdamp therefore lies not in the carbon dioxide present, but in the low per cent. of oxygen, which in some cases is nil.

While chemist for the Philadelphia & Reading Coal and Iron Co., the writer analyzed several hundred samples of blackdamp. It is from this work that the above conclusions have been reached.

Table 1, showing analyses of blackdamp, will give an excellent idea of the composition of this gas.

Analyses 1 and 2 were taken from "Blackdamp," by Haldane and Atkinson, Trans. Inst. Min. Eng., Vol. 8, p. 551. Analyses 3, 4, 5, and 6 are taken from the author's experience and are representative of blackdamp from anthracite mines.

It is therefore conclusively proved that miners coming into contact with blackdamp are affected, not by the carbon dioxide present, but by there being too little oxygen present to properly support life.

Ordinary air contains about 20 per cent. of oxygen. It therefore remains to determine what effect a lower per cent. of oxygen has on man, and whether the acetylene flame will act as a safe guide to determine these percentages and to clearly show the danger point.

It has been proved by Haldane and many others, and it is now generally accepted as a fact, that a man exerting himself will not notice anything unusual when breathing air having only 11 per cent. of oxygen. With 10 per cent. the breathing becomes deeper and more frequent. With 7 per cent. there is usually distinct panting and palpitation of the heart. With a slightly lower percentage, there is complete loss of consciousness.

It is therefore clear that the dangerous point commences below 11 per cent. of oxygen.

It has been proved by Messrs. Menner and Price, of The Colliery Engineer, and numerous other investigators, that when the acetylene flame is burned in an inclosed space until it is extinguished, and the confined air then analyzed, that this flame goes out when but 11 per cent. of oxygen remains. In other words, the acetylene flame requires more than 11 per cent. of oxygen to burn.

While these laboratory experiments are of great value, they still leave much to be desired. On account of the large number of acetylene lamps used in the mines with which the writer was connected, the question of the ability of the acetylene flame to detect blackdamp was of great importance. The writer therefore desired to conduct more practical tests looking toward the establishment of this point. In making these tests, the writer, accompanied by his assistants, carried an acetylene lamp into an atmosphere known to contain blackdamp and cautiously advanced it until a marked diminution of its illuminating power was observed; the air at this point was sampled and its effect on the writer and his assist-

Table 1. Analyses of Blackdamp

	O_2	N_2	CO_2	CH_4	Air	Blackdamp	Firedamp
1. Podmore Hall Colliery, stopping in No. 4 pit	1.45	82.56	10.64	5.35	6.94	87.71	5.35
2. Same, two months latter	.72	80.78	11.03	7.47	3.44	89.09	7.47
3.	10.09	89.38	.06	.48	48.23	51.29	.48
4.	5.08	91.81	2.92	.19	24.30	75.51	.19
5.	.90	93.01	3.05	3.04	4.33	92.63	3.04
6.	Trace	94.79	2.68	2.53	Trace	97.47	2.53

*Consulting Chemist.

ants noted. The lamp was then further advanced until extinguished and the same procedure repeated. These experiments have been repeated many times by the writer with closely agreeing results.

The average result of these many tests of blackdamp made as above, clearly shows that with from 16 to 17 per cent. of oxygen, the acetylene flame turns from its brilliant white color to a yellow shade closely resembling that of the oil flame.* As the oxygen percentage decreases, the illuminating power of the acetylene flame falls rapidly until at 12 to 13 per cent. of oxygen, it is practically nil, while at from 10 to 11 per cent. of oxygen, the lamp is extinguished.

These various tests, combined with those of Haldane and others, show beyond all question that the acetylene lamp gives ample warning, by a marked decrease in its brilliancy, of a corresponding decrease in the proportion of oxygen in the air, and that it goes out in blackdamp at a point where it is perfectly safe for a man to be.

This point is particularly and emphatically demonstrated by the tests made by the writer as he was frequently in blackdamp in which the lamp went out, and which the analysis of the sampled air showed to contain but from 10 to 11 per cent. of oxygen. He sustained no injurious effects whatever.

It is therefore apparent that the acetylene flame will give more than ample warning of the presence of blackdamp when conditions are far from dangerous. Moreover, miners, as they know from experience that they can work with perfect safety and comparative comfort long after the oil flame is extinguished, which occurs when the percentage of oxygen has fallen to about 17 per cent., have come to disregard the warning given by the oil lamp. They will, therefore, often remain in an atmosphere in which their lamps have been extinguished, and thus, with no knowledge of the condition of the air, they very readily incur a serious risk.

Much more respectful attention therefore, should be given to the warnings of the acetylene flame, for its indications cover a wider range of oxygen content, and its final warning is given at a point where retreat is necessary.

Whitedamp.—From long experience in mines, and as a leader in rescue parties, the writer has found that the great majority of asphyxiations in mines are caused by whitedamp, though blackdamp is often popularly blamed.

If blackdamp is present, it is at most only as a contributory cause. The writer has recently had called to his attention a case in which a mine worker lost his life. The cause of his accident was almost universally believed to be blackdamp, but after a thorough investigation, the writer has no hesitation in stating that whitedamp was the active cause.

No lamp, either oil or acetylene, will guard against whitedamp. The reason for this being that whereas in blackdamp, the oxygen content falls so low that the lamp cannot burn, a fatal amount of carbon monoxide in the air replaces so little oxygen that the flame does not feel the deficiency and therefore gives no warning. As shown above, 1 per cent. of carbon monoxide present in the air will kill a man in a few minutes.

In the matter of relative cost, the acetylene lamp shows a marked superiority over the oil lamp. It is difficult to formulate comparative figures setting this forth correctly, as the prices of the various oils used as illuminants vary so widely in the different fields, and the price of carbide is also subject to some variation, but where carbide can be obtained at 5.5 cents per pound, the cost is about 10 cents per week for an 8-hour shift.

An advantage of the acetylene flame not hitherto appreciated lies in the color of the light emitted. The spectrum of this light approaches so nearly to that of daylight, that objects seen by it possess much more clearly their natural colors than when seen by the light of other mine illuminants. This feature is especially valuable when these lamps are used by the breaker boys for picking coal, or when any attempt is made to clean the coal before loading in the mine. Of course, it is a matter of common knowledge that the acetylene lamp gives far more light than any other portable light used in the mines.

An important advantage of the acetylene lamp lies in the fact that not only does it consume far less oxygen than the oil lamp, but it gives off no smoke or fumes, and when properly working, no odor. It has also been found in the anthracite mines where large numbers of these lamps are used, that those suffering from miners' asthma are greatly benefited by their use.

Within the past few years fires totaling a loss of many hundred thousand dollars have originated in dry workings of the anthracite field which can be traced directly to the use of the open oil lamp. Fires are caused by these lamps principally in two ways: either by sparks blown from the wick by the ventilating current, eventually lodging in the timbering, or by smouldering oil-soaked wick cotton left by careless mine workers after cleaning their lamps. The writer has conducted a number of experiments to determine the distance at which the acetylene lamp will kindle dry wood, and has found that such material must be within a very few inches of the flame tip before ignition will take place.

Summary.—Carbon dioxide is unimportant in considering the question of blackdamp.

Blackdamp is really a deficiency in oxygen.

The oil flame is extinguished when the oxygen content of the air falls to 17 per cent.

The acetylene flame loses its brilliancy at 16 per cent., and is extinguished at 11 per cent. of oxygen.

Human life is endangered at 7 per cent. of oxygen.

*These same results were observed by Messrs. Meuner and Price and were published in The Colliery Engineer for August, 1913.

Whitedamp is responsible for most deaths attributed to blackdamp.

The acetylene flame gives more reliable indications of dangerous proportions of blackdamp than the oil flame.

Fire risk is increased by the use of open oil lamps, and decreased by the use of the acetylene lamps.

OBITUARY

ANDREW ROBERTSON

Andrew Robertson, the oldest active individual coal operator in the United States, died at his summer home in Asbury Park, N. J., on September 21, in his 88th year.

"Andy" Robertson, William Connell, and "Sandy" Fulton, were a noted trio of sturdy young men, personal friends from Nova Scotia, who many years ago began life in Pennsylvania, at the foot of the ladder, and who, by industry, natural intelligence, and economy, became wealthy and influential citizens of the United States.

William Connell died in Scranton, Pa., March 21, 1909, and Alexander Fulton died at Shamokin, Pa., on April 15, 1913.

The writer from boyhood knew Messrs. Robertson and Fulton, and from comparatively early manhood, knew Mr. Connell, and he always felt proud of the acquaintance and friendship of the three remarkable men.

All three were alike the possessors of positive characters, and men of simple tastes. Without the opportunities for much early education, they all rose to positions in the business and financial world where they commanded the respect of those whose opportunities in early life had been most liberal.

Mr. Robertson was born at Paisley, Scotland, on April 26, 1826, and when 7 years old, accompanied his parents to Nova Scotia, where his father found employment as a mine foreman. In Nova Scotia he found his first employment as a door boy, or trapper, in a coal mine. A few years later the family settled in New Philadelphia, Schuylkill County, Pa., where his mother died. The family then became scattered, and Andrew was thrown on his own resources. He learned his trade as a blacksmith, and followed this vocation at various small mines in Schuylkill County, and also acted as outside

Andrew Robertson

foreman at several collieries, until he secured a small lease on a seam of coal near New Philadelphia. With extremely limited finances, Mr. Robertson, at this small mine, was owner, outside foreman, inside foreman, blacksmith, and machinist. His tales of the makeshifts for machinery and his struggles to make the mine a success, were, while humorous, and in a measure pathetic, also inspiring. The little operation was not much of a financial success, but Mr. Robertson always considered it was of great value to him from the standpoint of experience, and expressed himself regarding his work there in the following language:

"I did not make much money, but the experience I gained, and habits of economy acquired and the hard work and long hours I endured, fitted me for my future life in a way that was more valuable to me than any money I might have made at that time."

After this experience, and others that followed in small operations, he went to California in 1853. Instead of joining in the precarious search for gold, he rigged up a blacksmith shop, and in the manufacture and repair of tools for the gold hunters, he accumulated a considerable amount of gold dust, which later was the basis of a large fortune.

On returning to Pennsylvania, he entered the coal mining business again in the Schuylkill region, and later operated extensive collieries in the Shamokin, Pa., field. He also engaged, in connection with Mr. Fulton, in operating on a royalty, the McIntyre Coal Co.'s bituminous mines, owned by Messrs. J. Langdon & Co., of Elmira. In 1865, he recognized the value of the coal resources of West Virginia, and made his first investment in that state, and at the time of his death he held many profitable investments in the West Virginia coal lands and collieries.

Mr. Robertson was a man of strong physique, an indefatigable worker, abstemious in his habits, and up to but a few months before his death had the ordinary appearance of a man fully 20 years younger than he was. His own tastes were exceedingly simple, and he was extremely economical in catering to his own person, but he was liberal in his care for his family, and in the support of religious and deserving charitable institutions. He is survived by two sons, Andrew D. and George W., of Shamokin, Pa., and one daughter, Mrs. Frank G. Clemens, of Pottsville, Pa.

Barium Chloride Hardening

The tool to be treated is submerged in a bath of 98 per cent. pure barium chloride and 2 per cent. soda ash. Barium chloride is melted at about 1,635° F. in graphite crucibles, and raised to a temperature of 2,100° F. at which it is held.

Large tools are preheated before immersion in this bath so as not to cool the barium chloride.

Tools heated in barium chloride can have their temper drawn by thrusting them in hot oil and watching for the proper color.

The Value of Coal Analyses

Classifications of Coals of the United States and Their Compositions as Shown by Analyses

*By N. W. Lord**

SIX classes of coal are recognized by the United States Geological Survey: 1, anthracite; 2, semi-anthracite; 3, semi-bituminous; 4, bituminous; 5, subbituminous or black lignite, and 6, lignite. I think it safe to say, however, that it is difficult to draw fast and sharp lines in the classification of a material, as variable as coal, in which samples are sure to be found on the border lines of almost any system of classification. In a valuable map prepared by Mr. M. R. Campbell and published by the United States Geological Survey, the coal areas of the United States are grouped (1), as high-grade coals, which include classes 1, 2, 3, and 4; (2), subbituminous or black lignite or class 5, and (3), lignite proper or class 6. The general qualities of these fuels correspond to the coals of certain regions, as the anthracites of Pennsylvania, the coking bituminous coals of Pennsylvania, the non-coking bituminous coals of Ohio and Illinois. As is known, coals differ not only in their physical structure, and their behavior under destructive distillation, some possessing the coking property, others, the so-called dry coals, showing but little or none of this quality, but also in their chemical composition and in their associated impurities.

The chemical analysis of coal as ordinarily made is what is known as the proximate analysis and is not in the strict sense of the word an analysis at all, but is merely a record of the nature of the decomposition that the coal undergoes when treated in a certain conventional manner. It involves the determination of the moisture or loss in weight when the coal is dried under certain specific conditions; of the volatile combustible matter or the material other than moisture which is driven off by heating the coal in a prescribed way in a platinum crucible; the fixed carbon, which is the loss in weight of the residue after driving out the volatile matter when the combustible matter is all burned out by heating in air; and, finally, the ash or combustible residue left from the foregoing treatment.

As contrasted with this, is the ultimate analysis of the coal in which the actual percentages of carbon, hydrogen, nitrogen, sulphur, oxygen, and incombustible residue or ash are determined. This latter method of analysis is strictly a chemical one and determines definitely substances present in the coal, and is independent entirely of the method of treatment.

The heating value of a coal is the amount of heat expressed in British thermal units developed by the complete combustion of 1 pound of the coal, and for all purposes in which coal is used as a fuel is, of course, the fundamental factor on which the fuel value of the material is based. Table 1 gives the proximate and ultimate analyses and the heating value of a typical coal in each of the foregoing six classes:

The following will locate and describe the coals given in Table 1: Class 1, Anthracite culm, Scranton, Pa. Class 2, Semianthracite, Coalhill, Ark. Class 3, Semibituminous, Mora, W. Va. Class 4, Bituminous coking, near Connellsville, Pa. Class 5, Bituminous non-coking, Ohio No. 6,

TABLE 1. COMPOSITION OF ILLUSTRATIVE COALS. CARLOAD SAMPLES

Class	1	2	3	4	5	6	7
Proximate Analysis of "Air-Dried" Sample							
Moisture	2.08	1.28	.65	.97	7.55	8.68	9.88
Volatile combustible	7.27	12.82	18.80	29.09	34.03	41.31	36.17
Fixed carbon	74.32	73.69	75.02	60.85	52.57	46.49	43.65
Ash	16.33	12.21	4.63	9.09	5.85	3.52	10.30
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Loss on air-drying	3.40	1.10	1.10	4.20	Undet.	11.30	23.50
Ultimate Analysis of Coal Dried at 105° C.							
Hydrogen	2.63	3.63	4.54	4.57	5.06	5.31	4.47
Carbon	76.86	78.32	86.47	77.10	75.82	73.31	64.84
Oxygen	2.27	2.25	2.68	6.67	10.47	15.72	16.52
Nitrogen	.82	1.41	1.08	1.58	1.50	1.21	1.30
Sulphur	.78	2.03	.57	.90	.82	.60	1.44
Ash	16.64	12.36	4.66	9.18	6.33	3.85	11.43
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calorific Value of "Air-Dried" Coal in British Thermal Units							
	12,472	13,406	15,190	13,951	12,510	11,620	10,288

TABLE 2. RESULTS IN TABLE 1 CALCULATED TO AN ASH AND MOISTURE FREE BASIS

Class	1	2	3	4	5	6	7
Proximate Analysis							
Volatile combustible	8.91	14.82	19.85	32.34	39.30	47.05	45.31
Fixed carbon	91.09	85.18	80.15	67.66	60.70	52.95	54.69
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis							
Hydrogen	3.16	4.14	4.76	5.03	5.41	5.50	5.05
Carbon	92.20	89.36	90.70	84.89	80.93	76.35	73.21
Oxygen	2.72	2.57	2.81	7.34	11.18	16.28	18.65
Nitrogen	.98	1.61	1.13	1.74	1.61	1.25	1.47
Sulphur	.94	2.32	.60	1.00	.87	.62	1.62
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calorific Value in British Thermal Units							
	15,281	15,496	16,744	15,512	14,446	13,203	12,889

*Address on the Fuels of the United States, delivered by the late Prof. N. W. Lord, of Columbus, Ohio.

Hocking Valley. Class 6, Subbituminous, black lignite, Uinta County, Wyo. Class 7, Lignite, Milan County, Tex.

These analyses are, with the exception of No. 5, made upon samples taken from carload lots. The analysis No. 5 is a sample of Hocking coal. It will be seen that there is a progressive decrease in the fixed carbon and increase in the volatile matter, and in the ultimate analysis an increase in the amount of oxygen and hydrogen. It is interesting to note that the maximum heating value of these coals rests with the semi-bituminous coals of the Pocahontas class, high in fixed carbon and comparatively low in volatile matter. The amount of moisture increases with the class of coal, but only in a very general way. It will be noted that the coals are reported in most cases as air dried. Coals freshly mined contain considerable water which is rapidly lost on exposure to air. The analyses are reported upon the coal in approximately the condition of moisture to which it will attain upon standing exposed to the ordinary air, the coal being in a coarsely crushed condition. If the coal be reported as made up of three main constituents, moisture, the combustible portion, and the ash, the typical analyses of the various groups may be corrected by eliminating, by calculation, the amount of moisture and ash and restating the composition of the remainder considered as coal. This has been done in Table 2.

The sulphur in the coal may also be regarded as one of its impurities, though in many cases a considerable portion of it, if not most of it, must be considered as in fact an inherent part of the coal proper, only a portion of it existing as iron pyrites. In many coals on the contrary a large percentage of the sulphur present is simply mechanically mixed pyrites. It is this uncertainty in regard to the disposition of the sulphur that makes such calculations as are exhibited in the foregoing tables only approximate. In these results it should always be remembered that in ultimate analyses of coal the oxygen determined can not be considered as more than approximately correct, being determined by difference and the results modified by the condition in which the sulphur exists. The foregoing outline serves to show that the coal from any district or mine may be considered as made up of coal proper and a certain amount of mechanically held impurities, consisting of ash, moisture and sulphur in form of pyrites. One of the results of the investigation of the fuels of the country has been to show that the coal proper is much less subject to variation in the mines of a given seam in a given district than are the relative proportions of the impurities, particularly ash and sulphur, which vary greatly in different portions of the same seam and frequently vary considerably from one portion of a field to the other. An interesting example of this is found in the Middle Kittanning, or No. 6 coal, of the Ohio series, in which the sulphur in certain portions of the seam covering areas of many square miles in extent will run under 1 per cent. the amount increasing, however, as the seam extends northward, until regions are reached where for the same coal the average sulphur content is over 5 per cent.

Variations in the ash take place in the same way but without so much regularity; yet throughout the entire extent of this district the variation in the ultimate composition of the actual coal itself is not material. The amount of moisture in coal, however, is a matter of considerable regularity and the power of the fuel to hold moisture seems to be closely connected with its general ultimate composition and nature of the seam. This, of course, refers to the moisture retained by the coal under ordinary conditions of handling. The effects of these impurities upon the quality of the coal are of two general kinds. Those acting as diluents or worthless admixtures reduce in proportion to their amount the heating value of the coal of which they form a part. Sulphur cannot strictly be regarded in this light, as it stands for a heating value of its own equal to approximately half of the coal that it replaces. Moisture, on the contrary, not only reduces the heating value of the coal as a diluent, but absorbs appreciable quantities of heat in its evaporation. Its presence in the coal bears unquestionably a relation of some importance to the nature of the combustion, and probably bears to some extent on the problems of smoke consumption, as it is probable that moisture in the gas of a furnace has a certain power of facilitating the completeness of combustion.

In addition to the effect of these materials as diluents, their positive injuriousness must be considered in many operations, as that of sulphur in the manufacture of iron and gas and the clinkering power of ash in obstructing drafts and leading to increased cost and diminished efficiency in the handling of the fuels.

The combustible portion of a coal from any district may be considered as agreeing quite closely in all samples from the same district, providing the geological designation of the seam is known to be the same. The variations shown in samples from the same mine in regard to ash, sulphur, and moisture show very clearly that these items can only be judged in a general way as applying to particular samples of the coal and therefore would in no wise diminish the necessity of control tests on any particular coal for its ash, moisture, and sulphur contents. Similarly, the heating value given will vary with the percentage of impurities, and it will be possible to judge what the average of the coal from a given district should be and so set an approximate standard to which shipment of any particular lot may be referred on the determination of the ash, moisture, and sulphur.

The use of the ultimate analysis of the coals in figuring the results of tests on boilers and other efficiency tests can be extended widely by applying them to similar coals after making due allowance for the ash, moisture, and sulphur considered as the impurities. In most cases such calculations will give results amply accurate for an ordinary control, to calculate the air required to burn the fuel, or similar data of combustion.

Notes on Mines and Mining

Reports on Conditions and Other Matters of Interest in Various Coal Fields

By Special Correspondents

THE latest census bulletin of the Dominion of Canada shows the importance of coal in the mineral production. The total value of the production throughout Canada during the year 1910, was $122,004,932. Coal, both as to tonnage and value, occupies the first place, with a value of $52,580,841; silver in ore and

Fig. 1. Shaft No. 42, Central Coal and Coke Co.

combination the second, with $18,899,240; gold, the third, with $10,402,973; clay products, fourth, with $9,562,302; nickel, fifth, with $8,276,313; copper, sixth, with $7,811,552; stone, seventh, with $6,472,474, and cement the eighth, with $5,851,055.

An enthusiastic meeting of the New Hazleton District Mine Owners' Association was held Tuesday, September 8, at New Hazleton, B. C. The officers elected were President, D. McLeod; Vice-President, Dr. H. C. Wrinch; Secretary-Treasurer, C. H. Sawle. The object of this organization is the development of the resources of the northern interior of British Columbia.

There is considerable discontent among the militia engaged in duty on Vancouver Island in the strike zone. The weeks of service, the low pay, viz., 1 dollar per day, is a hard sacrifice for men taken from their daily occupations. The policing of the coal area of Vancouver Island has been effected at the personal expense of a thousand or more militia men. It is generally believed that they are doing the work which special policemen should be doing. It is possible that censorship will be enforced over the telegraph and telephone lines leading out of Nanaimo and the strike-affected district.

The total number of arrests in connection with the recent riots has reached 150. It is expected soon to make this 200. There are about 225 special police now on duty near Nanaimo.

Complete and strict military supervision is being maintained. The area in which no liquor can be served has been further extended and now extends over a section of radius of 25 miles from Nanaimo.

About 40 men are clearing the workings of the Jingle Pot mine, owned by the Vancouver-Nanaimo Coal Co., which has recognized the union. There appears to be a growing desire among the striking miners to get back to work.

The Acting Minister of Mines of British Columbia has, according to the *Provincial Gazette*, approved of the board of examiners for the colliery of the Vancouver-Nanaimo Coal Mining Co., at East Wellington. The board is composed of the following: Representing the owners, H. N. Freeman, first alternate; J. Dixon, second alternate, and W. Moore. Representing the miners, Robert N. Hamilton, first alternate; James Bennie, second alternate, and James Cairns.

COLORADO

A Local Mining School.—The miners of the different collieries in Fremont, Colo., recently organized a mining school, known as the Fremont County School of Mines, at Florence, Colo., for the purpose of qualifying themselves for various official positions, as inspectors, superintendents, foremen, fire bosses, etc. The school is composed of students in the International Correspondence Schools, of Scranton, Pa., and is in charge of Professor McCurdy, of Florence, assisted by J. Q. McNatt, Division Engineer of the Colorado Fuel and Iron Co. The school is well attended and great interest is being shown in it by both the students and the mine officials.

KANSAS

Record Coal Production in Kansas. The status, from a production standpoint, of the coal mines of the Pittsburg district in southeastern Kansas, as compared with those of other parts of the world, can be made by figures on production secured for 1912.

Mackie C shaft was the second largest producer in the district. It worked about 200 men 207 days, and took out 166,000 tons of coal, 4,000 tons of which were used as engine fuel at the mine. This was within a fraction of an average of 802 tons a day. George K. Mackie, Scammon, Kans., is the owner, and during 1912 he sold his product from this shaft to the Central Coal and Coke Co.

The Central company's shaft No. 42, Fig. 1, was the largest producer, doing a little better than Mackie C. These two shafts are neighbors on the extreme southern edge of the

Fig. 2. Shaft No. 15, Western Coal and Mining Co.

field, in Cherokee County. It is the current opinion that Mackie C mine is almost worked out.

Shaft No. 15 of the Western Coal and Mining Co., on the extreme edge of the field, in Crawford County,

was the third largest producer. It worked 210¼ days and took out 157,731 tons. It is a new shaft and on the increase.

Many other shafts came near equaling these. Some took out as much as 1,000 tons of coal a day, but they did not work steadily, mainly because of lack of cars. It is seldom a shaft is shut down by inspectors in this field for more than a day or so, and not often for that length of time.

PENNSYLVANIA

"Each Opening must have a Foreman." Judge O'Boyle of the Luzerne County Court, in a lengthy opinion rendered August 26, 1913, sustains the provisions of the anthracite mine law, requiring the presence of a mine foreman in each separate and distinct shaft or opening. He decided that an assistant mine foreman, in the sense contemplated by the acts, if he gave instructions would not protect the defendant company, save only in so far as he is required by statute to give instructions along the line of his duties; and if instructions are given by him on any other subject matter not contemplated by his statutory duties, the principal is not protected by his certificate, as mine foreman. "A certified mine foreman is simply an employe of the owner or operator of the mine, and occupies the same relative position, to the operator, as any other employe, excepting in so far as the statute has specifically imposed on him certain duties in the mine for the protection and safety of the workmen. Hence, it is not his duty in the absence of a statutory requirement to instruct young or inexperienced workmen."

A preliminary report of the Pennsylvania Chestnut Tree Blight Commission now being distributed, gives an interesting summary of the work done under its direction in the effort to combat the destructive chestnut tree blight. The blight has been eradicated from the western part of the state, but spot infections will most likely reappear. Unless timber owners watch carefully, and destroy such infections promptly, the blight will spread rapidly and further heavy losses will inevitably follow. In eastern and southern Pennsylvania, a large percentage of the chestnut was badly infected before the commission was created by legislative enactment.

A somewhat unusual comparison is presented in the statistics covering labor employed in the anthracite and bituminous fields of Pennsylvania in 1912, as given by E. W. Parker, of the United States Geological Survey. Notwithstanding the decrease in the production of anthracite, more men were employed in 1912, than in 1911, whereas, in the bituminous mines the production showed a material increase with fewer employes.

The combined production of anthracite and bituminous coal in Pennsylvania, amounted in 1912, to 246,227,086 short tons, valued at $346,993,123 against 235,218,230 tons valued at $321,537,250 in 1911.

The total quantity of bituminous coal produced in Pennsylvania in 1912, was 161,865,488 short tons, valued at $169,370,497, and that of anthracite 84,361,598 short tons valued at $177,622,626. The average value per ton of anthracite increased from $2.17 in 1911 to $2.36 in 1912, and bituminous coal from $1.01 to $1.05.

WEST VIRGINIA

To Build a Steel Tipple.—The Pocahontas Consolidated Collieries Co., of which I. T. Mann, of Bramwell, W. Va., is president, is about to let the contract for the construction of a steel tipple at Lick Branch, 17 miles west of Bluefield, on the main line of the Norfolk & Western Railway. The tipple, which is to have a capacity of 3,000 tons in 10 hours, is to replace a wooden one that has outlived its usefulness. It is intended to handle the product of the Lick Branch and the Shamokin collieries. The cost will probably be somewhere around $65,000. The tipple is to be completed by April 1, 1914.

United States Bureau of Mines car arrived at Fairmont, W. Va., recently, for a 3-months course in instruction to first-aid and rescue teams.

This car has been stationed at Chiefton, W. Va., about 8 miles from Fairmont and 20 from Clarkesburg on the electric car line. Electric light and water have been connected to the car by the Consolidation Coal Co., which company has also turned over to the Bureau, for their use while in this region, a residence for use in first-aid instruction and a small mine for the rescue work. This mine, while small, is regularly worked by the Consolidation Coal Co., and makes an ideal trying-out and practice place for the use of the Draeger outfits. The workmen have been withdrawn and the mine filled with smoke and gases.

All the coal companies of the Fairmont-Clarksburg region are sending teams. The Consolidation Coal Co., having some 45 mines in this vicinity, expects to have trained from 12 to 15 teams. The government force trains two teams of five men each every week, giving each man a full 6 days instruction. The first instruction was given Monday morning, October 6.

The Consolidation Coal Co. already has a rescue outfit consisting of five sets of Draeger outfits and all necessary equipment for rescue and first-aid work and 15 trained men located at Fairmont. It is the intention to utilize these men and the outfits in the present instruction work to supplement the government outfit.

The Monongahela Valley Electric Traction Co., is now operating from Clarksburg to Weston (about 25 miles), this is mining territory on the B. & O., and gives a new outlet by trolley. This line now operates from Mannington to Fairmont to Clarksburg to Weston, a distance of about 75 miles.

Water attains its greatest density at 39.1° F., when it weighs 62.425 pounds per cubic foot. The specific gravity of water at 62° F. being 1, the specific gravity of ice is .922.

Practical Talks on Coal Mining

For men who desire information on Coal Mining and related subjects presented in a simple manner

Mechanics of Mining

An Explanation of the Principles Underlying Calculations Relating to Engines, Pumps, and Other Machinery

By R. T. Strohm, M. E. (Continued from October)

IF THE weight of the body is doubled the centrifugal force is doubled. This may be shown very simply. In the example just given, let us suppose that the weight of the body is taken as 20 pounds instead of 10 pounds and that the other conditions remain the same. Then, the centrifugal force is $.00034 \times 20 \times 2 \times 500^2 = 3,400$ pounds.

This result, it will be observed, is twice as great as the value previously found, proving that doubling the weight doubles the centrifugal force.

Trebling the weight would treble the centrifugal force; in other words, the centrifugal force increases or decreases in the same ratio as the weight is increased or decreased.

The same thing is true of the radius of swing of body. If the distance from the center of rotation to the center of gravity of the body is increased or decreased, the centrifugal force is increased or decreased in the same ratio. For instance, suppose that in the original example the distance from the center of gravity to the center of rotation is only 1 foot, or one-half as great. Then, the centrifugal force is $.00034 \times 10 \times 1 \times 500^2 = 850$ pounds.

This value is only one-half of that found in solving the original example, showing that the centrifugal force is made only half as great by halving the radius.

In the matter of change of speed, however, the same thing does not hold true. The centrifugal force varies as the square of the number of revolutions per minute of the body. To illustrate this point, suppose that in the original example the speed of rotation is made only one-fifth as great, or 100 revolutions per minute.

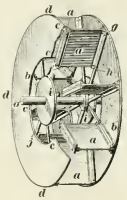


Fig. 38

Then, as the square of $\frac{1}{5}$ is $\frac{1}{25}$, it may be expected that the centrifugal force is only $\frac{1}{25}$ of that previously calculated.

On applying the rule or the formula and taking 100 as the number of revolutions per minute, the centrifugal force is $.00034 \times 10 \times 2 \times 100^2 = 68$ pounds.

As this result is $\frac{1}{25}$ of 1,700 pounds, it is proved that the centrifugal force varies as the square of the speed. If the speed is doubled, the centrifugal force is made four times as great; if it is trebled, the centrifugal force is increased nine times; and so on for any other rate of decrease or increase.

In the preceding article it was shown that when a body of any kind is rotated around some fixed point, centrifugal force is set up, and that there is a tendency for the body to move away from the center around which it is rotating. In connection with mining machinery there are many instances in which centrifugal force is made use of to obtain a desired result. One of the most familiar is the application of the principle of centrifugal force to the action of the centrifugal fan, such as is used in the ventilation of mines.

The construction of one of the simplest forms of centrifugal fan is shown in Fig. 38. It consists of a number of blades *a* that are simply flat plates of the same size. These blades are held between two circular plates *b* that are cut away at the center to form two flat rings. The blades are set radially; that is, they all point directly outwards from the center of the fan. They are riveted to angle irons that are in turn riveted to the side plates *b*.

At the center is a shaft *o* that passes directly through the fan from side to side. It has two spiders or flanges *i* fixed to it, and the side plates *b* are attached to these spiders by short arms *j*. When the shaft is placed in bearings at each end and is turned, the whole fan is rotated. In the illustration, a part of one side plate is shown broken away, so that the arrangement of the blades can easily be seen.

When the shaft is rotated and the fan is turned, centrifugal force is set up in every particle that turns around the shaft. But as the blades, the side plates, the arms, and the spiders are all joined together so as to form one piece, they cannot move outwards under the action of the centrifugal force; in other words, the centrifugal force set up is not great enough to cause any of the rivets to give way nor to break any part of the fan.

But there is one thing that is free to move outwards under the impulse of the centrifugal force. This is the air in the fan. Between each pair of adjacent blades and the side plates is a wedge-shaped space that contains air. The air in this space has weight. It is true that air is not very heavy, as a cubic foot of atmospheric air weighs only about .08 pound. Yet the space between each pair of blades is filled with air that weighs from a small fraction of a pound to several pounds, depending on the size of the fan and the condition of the air.

Now, when the fan is rotated, each of these wedge-shaped volumes of air is carried around the shaft by the blades, and centrifugal force is set up in the air itself, tending to cause it to move outwards, away from the shaft. As the wedge-shaped openings are not closed at their outer ends, the air is free to escape beyond the outer edges of the blades and side plates.

But, when the air between a pair of blades moves outwards under the action of the centrifugal force, the tendency is to leave a vacuum in the space that it occupied; consequently, other air flows in through the openings at the center of each side plate and fills the space originally occupied by the air that is thrown outwards from the fan. In this way a steady flow is set up, the air entering the fan at the center and leaving it at the outer edge.

This, then, is the principle of action of the centrifugal fan: The centrifugal force set up by the rapid turning of the fan throws the air in the fan outwards, away from the center, and as fast as this air is displaced, a fresh supply enters at the center of the fan, thus keeping up a steady circulation as long as the fan continues to run.

A centrifugal fan of the type shown in Fig. 38 may be either an open-running fan or a closed-running fan. An *open-running fan* is one that discharges the air directly from the fan into the atmosphere in all directions. There is no casing surrounding such a fan, and as soon as the air in each chamber is thrown out, it mingles with the surrounding free air. A *closed-running fan*, however, has a tight spiral casing built completely around it, and the air that is thrown out from the fan is caught in this casing and is led by it in any desired direction.

In speaking of the size of a centrifugal fan it is usual to state the outside diameter and the width, but the diameter of the opening through which the air enters at the center of the fan should likewise be stated. In Fig. 38, the outside diameter of the outer circle *d d d*, formed by the side plate and the width of the fan, is the width *e g* of the blades. The diameter of the circle *c c c*, or the diameter of the intake opening, is the inner diameter of the fan. Sometimes, instead of stating the inner diameter, the length or depth *e f* is given. The diameter of the intake opening can then be found very easily by subtracting twice the length of the blade from the outside diameter of the fan.

(To be Continued)

Electricity in Mines

An Explanation of the Use of the Voltmeter and the Ammeter—Rules for Their Care and Operation

By H. S. Webb, M. S. *(Continued from October)*

THE current, in amperes, or the drop in volts, can be obtained from the readings of an ammeter or voltmeter properly disposed in the circuit. Suppose, for example, that the terminals of a battery are connected to an unknown resistance,

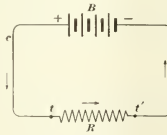


Fig. 20

and that it is desired to know the strength of current flowing through the circuit, and also the difference of potential required to drive the current through the unknown resistance. In Fig. 20, let *B* represent the battery that forces current through a resistance connected between *t*, *t′*; *c*, *c′*, *c″* are three large conductors for making necessary connections. There is practically a steady current flowing through the circuit. The strength of the current will be the same in all parts of the circuit. Assuming that the electromotive force does not vary, the current in the circuit will remain constant so long as the resistance of the circuit is not altered.

If an ammeter is inserted in any part of the circuit, as between *c′* and

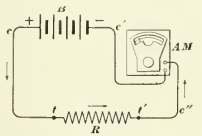


Fig. 21

c″, Fig. 21, it will measure the total current flowing through the circuit. The resistance of the ammeter is so small that its insertion does not appreciably change the total resistance of the circuit, nor the current flowing. Assume the current to be 1.2 amperes. The next operation is to find the electromotive force required to drive a current of 1.2 amperes through the resistance *R*; this is accomplished by connecting the terminals *t*, *t′*, Fig. 22, of the unknown resistance *R*, to the binding

posts p, p' of the voltmeter VM by voltmeter leads l, l'. Any small wires of reasonable length may be used for voltmeter leads, as the current they transmit is exceedingly weak, owing to the high resistance of the voltmeter. Assume that the voltmeter needle indicates a potential difference, or drop, of 6 volts;

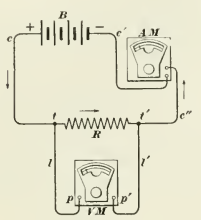


Fig. 22

this is the electromotive force required to force a current of 1.2 amperes through the unknown resistance R; or, in other words, the difference of potential between the terminals t, t' is 6 volts. From these readings of the current and voltage, the resistance of conductor R is determined by Ohm's law. The drop is 6 volts and the current is 1.2 amperes; therefore, resistance of $R = 6 \div 1.2 = 5$ ohms.

Suppose that the resistance of R is known, and that it is required to find how much current the battery will send through it. An ammeter connected in series, as shown in Fig. 21,will show this at once. If no ammeter is available, and a voltmeter is, the same information can be obtained by connecting the voltmeter, as in Fig. 22, and then applying Ohm's law. Suppose that the voltmeter shows a drop of 6 volts; since the drop across the conductor is 6 volts and its resistance 5 ohms, the current equals $6 \div 5 = 1.2$ amperes. Ammeters and voltmeters (or their equivalents, galvanometers) are indispensable for measuring the resistance of conductors while current is flowing through them.

The following precautions must be observed when using voltmeters and ammeters:

1. Instruments, when in use, should be set in a horizontal position, unless they have been designed and adjusted for use in a vertical position.

2. To insure that the needle is not sticking and thereby introducing error, the case should be tapped lightly with the finger each time a reading is taken, until it is certain that the needle does not stick.

3. Never allow any of the connecting wires to touch the brass cover of a voltmeter; the cover should be, and usually is, insulated from all inside electrical connections; but should this insulation become defective, careless handling of the external connections may establish a short circuit that will destroy the instrument or injure the operator.

4. Most direct-current voltmeters or ammeters have a positive connecting terminal and a negative connecting terminal; the positive terminal is marked + (plus). As far as possible, avoid getting the connections to the instrument interchanged, for the result may be to throw the needle to the wrong side of zero and strain its mounting or bend the needle.

5. When using these instruments on portable work, such as taking measurements on electric cars, they should be placed on waste or excelsior in order to take up the jar.

6. Never connect an ammeter as a voltmeter. A voltmeter has high resistance and can be safely connected to a circuit having any voltage within its range; but an ammeter has a very low resistance, and a small potential difference applied directly to the ammeter will send an excessive current through it. Therefore, if an ammeter is connected across a powerful source of electromotive force in the same way as a voltmeter, the ammeter will be destroyed.

7. Do not attempt to use voltmeters or ammeters for measuring pressures or currents beyond their range, as indicated by the highest reading on their scales.

8. The working parts of all high-grade instruments, such as the Weston, are sealed; if the seal is broken, the manufacturing company will assume no responsibility for defects. Therefore, when a high-grade instrument becomes defective, return it at once to the factory.

(To be Continued)

Mine Ventilation

Use and Construction of Undercasts—Sollars—Advantages and Disadvantages of Strong Overcasts, Stoppings, Etc.

Written for The Colliery Engineer (Continued from October)

UNDERCASTS.—In rare instances the air from the cross-entries is carried into the main return through a channel passing under instead of over the main intake. In such cases the channel or passageway is known as an undercast. This may be built of timber or excavated through the rock in the same way as an overcast, the latter, as shown in Fig. 10, being the most expensive but in the end the cheapest. As stated last month in connection with rock overcasts, this form of construction does not leak, requires no repairs, and is indestructible in event of an explosion.

However, undercasts are usually made of wood in the box style similar to the overcast shown in Fig. 9, in the October issue. They are unsatisfactory, as it is practically impossible to keep them air-tight, be-

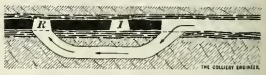


Fig. 10. Undercast

cause they are subject to a constant jar due to the passing of men, mules, cars, motors, etc., which soon loosens the joints, no matter how well built they may have been at the

outset. In event of an explosion, wooden undercasts are a source of much more trouble than are wooden overcasts. If blown up, not only is the ventilation destroyed but the haulage system as well, since the rails rest upon the timbers of the undercast. Again, undercasts being below drainage level frequently contain more or less water. This not only contracts the size of the passage through which the air must travel, but may also prove a serious menace to the escape of the men following an accident should the airway be the only remaining outlet.

Air Sollars.—The word, sollar, is commonly used to designate one of the platforms upon which rest the feet of the ladders in an escape shaft, but, by extension, it is made to include any platform or horizontal partition of plank, and particularly the partition shown in Fig. 11, by means of which an entry is sometimes divided horizontally into two distinct parts or passages, one above the other. The upper portion is used as a traveling way and haulageway, while the lower, which also answers for a drainway, is intended as an intake for the air which returns through the upper part.

Air sollars were at one time quite extensively employed in the ventilation of rock tunnels, but their use has been almost entirely done away with since the introduction of compressed air for operating rock drills. At one time mines were often opened with but a single entry, from which rooms were turned to both the right and the left. Until some one of the inner rooms was driven through to the outcrop or to a connection with the furnace shaft, a circulation of air was impossible unless an air sollar was carried along the bottom of the single entry; and they were used for this purpose. However, the use of single entries is prohibited in most states, and ventilation by means of sollars is a thing of the past, except in driving prospecting drifts in exploring new coal fields. The method of their construction is made clear in the illustration. The lower portion, *a*, is excavated in the fireclay floor after the coal above it has been mined out. This excavation is rarely more than 2 or 3 feet deep so that the area of the intake portion of the heading is much less than that of the return. Floor beams of round logs or of, say, $6'' \times 12''$ sawed lumber are set in hitches in the rock and are spaced

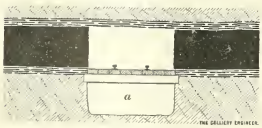


Fig. 11. Air Sollar

at the proper intervals to sustain the weight of the track and loaded cars which come upon them. The flooring may be a single, or double, layer of plank with a sheet of brattice cloth, building paper, etc., between to make the partition more nearly air-tight. The space between the end of the planks and the ribs is rammed tight with clay.

Strength of Overcasts, Stoppings, Etc.—It is an undecided question whether overcasts, stoppings, and other devices for regulating or directing the air-currents in a mine should or should not be made strong enough to resist the violently destructive action of a coal-dust explosion. It is apparent that in the course of time, in the warm, moist air of the mine, all wooden structures will rot and that iron-work will rust and will even be corroded or eaten away if acid water is present. Further, the jars due to heavy blasting or to falls of roof, will sooner or later loosen the joints of framed structures and will, thus, permit the leakage of air, even if this has not already been brought about by the atmospheric agencies mentioned. But it is a comparatively simple matter to make overcasts, etc., strong enough and of material durable enough to resist the effects of these agencies, and a little watchfulness will detect air leakages before they become serious.

The question then arises, assuming it is possible to do so, should overcasts and brattices be built strong enough to resist the shattering effects of a violent dust explosion? The answer is usually in the negative. Were these structures indestructible it is apparent that (the mine being dry and dusty) an explosion originating at any given point would sweep entirely through the workings like the blast from a rifled gun, completely filling them with afterdamp and resulting in the death of all the mine workers. On the other hand, the destruction of the overcasts and stoppings, will frequently so reduce the temperature and pressure by permitting of the expansion of the burning dust and gases, that the explosive wave is stopped and the lives of many saved through the failure of the afterdamp to penetrate to the inner portions of the mine. And this failure of the afterdamp to reach the interior of the mine is materially assisted by the destruction of the brattices, which short-circuits the air outby the working places. Our readers will undoubtedly recall cases in their own experience, where the circulation of air having been destroyed by the demolition of the brattices and overcasts, the men inby the point of origin of the explosion have either been rescued because they remained at their posts, or would have been rescued had they not attempted to leave the mine and thus ran into a body of afterdamp. One of the saddest features in mine recovery work is the finding of the bodies of the dead a half a mile or more from their working places and to note the change in the character of the footprints as the victims slowly succumbed to the deadly monoxide. It cannot be too strongly impressed upon all mine workers that when an explosion occurs between them and the drift mouth, their chance of escape is infinitely better, if, instead of attempting to make their way to daylight, they will go further into the mine or remain at their posts and there build a brattice of any available material behind which they are comparatively safe until the rescue crew arrives.

(*To be Continued*)

Answers to Examination Questions

Questions Selected from Those Asked at the Examination for Mine Manager, Mine Examiner, and Hoisting Engineer, Held at Springfield, Ill., January and April, 1913.

(*Concluded from October*)

Note.—The numbers do not correspond with those of the Examination Questions as asked. After each question is given the nature of the examination, the number of the question, and the date at which held. M. M. = Mine Manager; M. E. = Mine Examiner; H. E. = Hoisting Engineer.

Ques. 21.—How many 3-inch pipes will present a sectional area equal to that of one 12-inch pipe? All being of equal length, will this number of 3-inch pipes discharge more or less water in a given time than one 12-inch pipe, and why? (M. M., 13, Jan.)

Ans.—The areas of circles are proportional to the squares of their respective diameters. In this case we have that the areas are proportional to 3^2 and 12^2, or as 9 and 144, which is the same as 1 and 16. From this, one 12-inch pipe presents as great an area as sixteen 3-inch pipes and it will take this number of the smaller pipes to equal in area the one large one. The same result may be had as follows: $12 \div 3 = 4$, and $4^2 = 16$.

Sixteen 3-inch pipes will not, having the same length and head, discharge as much water as one 12-inch pipe, because the friction is much greater. The rubbing surface in sixteen 3-inch pipes is four times as large as that in one 12-inch pipe. Under the conditions given in the problem we can assume that the discharges from the pipes are proportional to the square roots of the fifth powers of the respective diameters. If N be used to denote the number of 3-inch pipes which will discharge as much water as one 12-inch pipe we have $N = \frac{\sqrt{12^5}}{\sqrt{3^5}} = \sqrt{\frac{12^5}{3^5}} = \sqrt{\left(\frac{12}{3}\right)^5} = \sqrt{4^5} = 32$, or it will require thirty-two 3-inch pipes to discharge as much water as one 12-inch pipe, under the same conditions of length and head.

Ques. 22.—The hand of an anemometer turns 3.75 times per minute. The airway is 5.5 ft. × 9 ft. What is the velocity of the air-current, allowing 3 per cent. for resistance of anemometer? (M. E., 11, Jan.)

Ans.—The area of the airway does not enter into the problem, which only deals with the velocity recorded by the revolutions of the anemometer. This instrument indicates a velocity of $3.75 \times 100 = 375$ feet a minute. Owing to friction, etc., it records 3 per cent. less than it should. Hence, the actual velocity of the air is $375 \div (1.00 - .03) = 386.6$ feet per minute. The volume $= 386.6 \times (5.5 \times 9) = 19{,}137$ cubic feet per minute.

Ques. 23.—Find the horsepower of an engine having two cylinders 30 inches in diameter, and 5-foot stroke, when making 60 strokes per minute with an average steam cylinder pressure of 30 pounds per square inch, and an average back pressure of 4 pounds per square inch. (H. E., 9, Apr.)

Ans.—In engines with two cylinders the cranks are set at right angles so that when one is exerting its full force the other is on its dead center and doing no work. Hence, the horsepower of such an engine will be measured by that of one of its individual cylinders. The mean effective pressure on the cylinder is equal to the pressure of the steam less the back pressure, or is $30 - 4 = 26$ pounds per square inch. The horsepower may be found by substituting in the formula $\text{H. P.} = \frac{PLAN}{33{,}000}$

$$= \frac{26 \times 5 \times (.7854 \times 30^2) \times 60}{33{,}000}$$

$= 167.076$. In this formula P = the average or mean effective pressure upon the cylinder in pounds per square inch = 26; L = length of stroke in feet = 5; A = area of cylinder in square inches = $.7854 \times 30^2$; and N = number of strokes per minute = 60.

Ques. 24.—Given 10,000 cubic feet of air per minute through an airway 10 ft. × 8 ft., with a pressure of 10 pounds per square foot, what is the length of the airway? (M. M. 7, Jan.)

Ans.—By substituting the value for s, $(s = l\,o)$ the formula for p becomes, $p = \frac{k\,l\,o\,v^2}{a}$. By transposing, we have, $l = \frac{a\,p}{k\,o\,v^2}$. From the data given, $a = 8 \times 10 = 80$ square feet; $p = 10$ pounds; $k = .00000002$; $o = 2\ (8 + 10) = 36$ feet; and $v = \frac{q}{a} = \frac{10{,}000}{80} = 125$ feet per minute. Substituting in the formula,

$$l = \frac{80 \times 10}{.00000002 \times 36 \times 125^2} = \frac{800}{.01125}$$

$= 71{,}111$ feet, or about 14 miles, a most extraordinarily long airway.

Ques. 25.—With a water gauge of 1.75 inches, what is the pressure, and what would be the velocity of a wind (no friction taken into account) caused by such a pressure? (M. M., 6, Apr.)

Ans.—The pressure is $1.75 \times 5.2 = 9.1$ pounds per square foot. Assuming the weight of a cubic foot of air to be equal to .076 pound, the head or height of air column corresponding to any pressure is $h = \frac{p}{w} = \frac{9.1}{.076} = 119.74$ feet (about). The velocity due to this head, neglecting friction, is found by substituting in the formula,

$v = \sqrt{2\,g\,h} = \sqrt{2 \times 32.16 \times 119.74} = \sqrt{7701.6768} = 87.76$ feet (about) per second. It is to be noted that this velocity is purely theoretical and could not be secured in an airway owing to the friction.

Ques. 26.—If a collar, or cross-beam, 10 inches in diameter and 6 feet between notches bears a certain load, what should be the diameter of a collar 12 feet between notches to bear the same load? (M. M., 14, Apr.)

Ans.—For the same load, the strength of collars varies as the cubes of their diameters and inversely as the squares of the lengths or spans. Calling the unknown diameter y, we have $y^3 : 10^3 = 12^2 : 6^2$. From this $y^3 = 10^3 \times \frac{12^2}{6^2} = 10^3 \times 2^2 = 10^3 \times 4$. From this, $y = 10\sqrt[3]{4} = 15.87$ inches, practically 16 inches. Note that the calculation above is based upon the assumption that the "certain load" means a certain load per foot of length. If this is true it is apparent that the beam of 12-foot span bears twice the total load of the 6-foot beam because it is twice as long and the load per foot is the same. Thus, if the load in each case is 100 pounds per foot of length, the 6-foot beam will be supporting a total load of 600 pounds, and the 12-foot beam one of 1,200 pounds, or twice as much. If we assume that each beam is required to support the same total load, be the same 1,000 or 5,000 pounds, regardless of the length, then the strength will vary directly as the cubes of the diameters and inversely as the lengths (not the squares of the lengths), and $y^3 = 10^3 \times \frac{12}{6}$, whence $y = 10 \times \sqrt[3]{2} = 12.599$, say, 13 inches.

Ques. 27.—The water gauge in a mine reads 2.5 inches; we have a 60-horsepower engine running the fan What quantity are we getting? (M. E., 8, Apr.)

Ans.—Assuming that the efficiency of the fan and engine is 100 per cent., that is, that they are operating with theoretical perfection, the quantity in circulation is $q = \frac{u}{p} = \frac{60 \times 33{,}000}{2.5 \times 5.2} = \frac{1{,}980{,}000}{13} = 152{,}000$ cubic feet per minute. In this formula u = units of work involved in producing the ventilation, and is equal to the horsepower multiplied by the units of work in 1 horsepower, or 33,000. No such quantity as the above is obtainable in practice. The efficiency of the ventilating plant will probably vary between 50 and 80 per cent. of the theoretical. Thence the actual volume will be reduced to between 76,000 cubic feet and 120,000 cubic feet.

Ques. 28.—If 1 pound of coal develops 12,000 units of heat by its complete combustion, how much water at 60° F. should be converted into steam at 212° F. by the consumption of 150 pounds of such fuel, assuming that there is no loss of heat during the operation? (H. E., 9, Jan.)

Ans.—It requires $212 - 60 = 152$ units of heat to raise 1 pound of water from 60 degrees to 212 degrees, and 965.8 additional heat units will be required to raise the water at 212 degrees to steam at the same temperature. Hence, the total amount of heat required to convert 1 pound of water at 60 degrees into steam at 212 degrees is $152 + 965.8 = 1{,}117.8$ British thermal units. Since 1 pound of the coal develops 12,000 British thermal units, 150 pounds will develop $12{,}000 \times 150 = 1{,}800{,}000$ British thermal units. This number of heat units (British thermal units) will convert $1{,}800{,}000 \div 1{,}117.8 = 1{,}610+$ pounds of water at 60° F. into steam at 212° F.

Ques. 29.—To light a mine with 200 lamps of 16 candlepower each, what mechanical energy would have to be available for conversion into electricity? (M. M., 11, Apr.)

Ans.—Assuming that these are ordinary carbon filament lamps, they will require about 60 watts each, or $200 \times 60 = 12{,}000$ watts for all. As 746 watts = 1 mechanical horsepower, there will be required $12{,}000 \div 746 = 16.08$ horsepower. This is the net horsepower, no allowance being made for loss at the generator or in transmission. In a generator of this size we may assume an efficiency of 85 per cent. with an additional loss in transmission of 10 per cent. Then if y = total horsepower required, we have $(y \times .85) \times (1.00 - .10) = y \times .765 = 16.08$. From this, $y = 16.08 \div .765 = 21.02$ horsepower (mechanical). In these calculations those values have been used which give the maximum horsepower that can be required. Ordinarily these lamps may be figured on to consume about 56 watts, and the loss at the generator and in transmission might be less.

Ques. 30.—What size of pipe should be used in transmitting 1,000 cubic feet of air per minute a distance of 4,000 feet at sea level, when the initial gauge pressure is 60 pounds? (M. M., 18, Apr.)

Ans.—Assuming that the question means 1,000 cubic feet of free air a minute, and that the temperature is the so-called standard one of 60° F., and that the pressure of the barometer at sea level is 30 inches, we may use the formula, $d = \sqrt[5]{\frac{w\,l\,q^2}{r\,c^2\,p}}$. In this formula,

d = the diameter of the pipe in inches;
l = length of pipe in feet = 4,000;
w = weight of a cubic foot of air at 60° F. and 30 inches = .0766;
q = quantity of free air transmitted per minute = 1,000;
p = the initial pressure = 60 pounds;
c = a constant which varies with the size of the pipe, but for those of moderate dimensions may be assumed at 60; and
r = the number of compressions.

As a gauge pressure of 60 pounds means a total pressure of 60 + 15 (one atmosphere = 15 pounds, approximately) = 75 pounds, the number of compressions above the atmosphere $= 75 \div 15 = 5 = r$. Substituting, we have $d = \sqrt[5]{\frac{.0766 \times 4{,}000 \times (1{,}000)^2}{5 \times (60)^2 \times 60}} = \sqrt[5]{284+} = 3.095$ inches. While a 3-inch pipe would do, it would be better to employ a $3\frac{1}{2}$-inch pipe for the purpose.

Ques. 31.—Show by a problem how you would find the quantity and weight of air passing in an entry 6 feet high and 10 feet wide, the velocity being 600 feet a minute. Assuming the temperature was 70° F. (M. E., 10, Apr.)

Ans.—The area of this entry is $6\times10=60$ square feet. The quantity passing per minute is equal to the area multiplied by the velocity, or to $60\times600=36{,}000$ cubic feet per minute.

Assuming the barometer to measure 30 inches of mercury, the weight of this volume of air is

$$36{,}000\times\frac{1.3273\times30}{460+70}$$

$$=36{,}000\times.0751=2{,}703.6 \text{ pounds}$$

Ques. 32.—The belt wheel on a dynamo is 2 feet in diameter and runs at a speed of 600 revolutions per minute; the belt wheel on the engine is 14.5 feet; what speed must the engine run? (H. E., 7, Apr.)

Ans.—The number of revolutions of the engine will be inversely proportional to the diameters of the two belt wheels. This ratio is $14.5\div2=7.25$. Hence, if the belt wheel on the dynamo makes 600 revolutions per minute, that of the engine will make $600\div7.25=82.75$, say, 83 revolutions per minute.

Ques. 33.—From an inner sump in a mine, the entry rises 1 in 14 for a distance of 78 feet, and then falls 1 in 21 for 676 feet; will a siphon work if put in place under such conditions?

If the siphon is 2 inches in diameter, state how much the line will discharge in gallons per hour. (M. M., 17, Jan.)

Ans.—The head due to the rise $=78\div14=5.57$ feet, and that due to the fall is $676\div21=32.19$ feet. The effective head is $32.19-5.57=26.62$ feet. Under these conditions a siphon will work, since the atmosphere will support a column of water about 34 feet high at sea level.

Various formulas may be employed for determining the discharge. One of the most satisfactory is Gould's formula for small pipes with rough inside surface, $Q=.89\sqrt{D^5\,h}$, in which D is the diameter of the pipe in feet or $\frac{2}{12}=\frac{1}{6}$, and h is the fall per 1,000 feet $=(26.62\times1{,}000)\div(676+78)=26{,}620\div754=35.30504$. Substituting in the formula we have

$$D=.89\sqrt{\left(\frac{1}{6}\right)^5\times35.30504}$$

$$=.89\sqrt{\frac{35.30504}{7.776}}=.89\sqrt{.004540}$$

$=.89\times.0672=.0598$ cubic foot per second, or $.0598\times60\times60=215.28$ cubic feet per hour. On the basis of 1 cubic foot containing 7.48 gallons, the discharge will be $215.28\times7.48=1{,}610+$ gallons per hour.

Ques. 34.—A barometer registers 30 inches at the surface; what will it register at a point 1,890 feet below the surface? (M. M., 5, Jan.)

Ans.—A simple formula used for determining the depths of shafts is $H=55{,}000\left(1-\sqrt{\frac{r}{R}}\right)$, in which $H=$difference in level between the two stations, and r and R are the readings of the barometer at the two stations, R being the greater and r the less. This may be transposed to read $\sqrt{\frac{r}{R}}=1-\frac{H}{55{,}000}$. By substituting the values of R and H, $\sqrt{\frac{30}{R}}=1-\frac{1{,}890}{55{,}000}=1-.0344=.9656$. By squaring both sides and reducing, $R=30\div(.9656)^2=30\div.9324=32.17$ inches.

This calculation is based upon the assumption that the temperature is the same at the bottom as at the top of the shaft, and that the fan is not running. If the fan is in operation the pressure producing the ventilation will affect the reading of the barometer.

Ques. 35.—How many horsepower will it take to pull 20 loaded cars up an incline 400 feet long in 1 minute, the weight of the coal in each car being 3,000 pounds, and the weight of the empty car 900 pounds; the resistance of the rope and pulleys is 13 per cent. and the grade is 7 per cent.? (M. M., 8, Apr.)

Ans.—The formula for the horsepower is H. P. $=\frac{\text{Wt.}\times\text{Dist. raised}}{33{,}000}$, in which the given weight is raised the given distance in 1 minute of time. In the case in question, the weight equals $3{,}000+900=3{,}900$ pounds for one car or $3{,}900\times20=78{,}000$ pounds for the entire trip. There is a further resistance to be overcome which is equivalent to raising, and that is the resistance of the rope, pulleys, etc. This is stated to be 13 per cent. of the total weight raised and is $78{,}000\times.13=10{,}140$ pounds. Hence, the total weight is $78{,}000+10{,}140=88{,}140$ pounds. The distance raised is 400 (length of incline)$\times.07$ (per cent. of grade) $=28$ feet. Substituting in the formula,

$$\text{H. P.}=\frac{88{,}140\times28}{33{,}000}=74.78 \text{ H. P.}$$

Ques. 36.—An engine showed by its card that it developed 60 horsepower. At the time the card was taken, the engine was pulling a load of 3 tons up a shaft 148.5 feet in depth in 30 seconds; what is the efficiency of the engine, the friction of the load being neglected? (H. E., 13, Apr.)

Ans.—The load raised is $3\times2{,}000=6{,}000$ pounds. As this load is raised in 30 seconds, or $\frac{1}{2}$ minute, in the formula we multiply by 2 as the engine will presumably raise this load twice as far in 1 minute, and horsepowers are figured on the basis on a minute of time. Hence,

$$\text{H. P.}=\frac{2\,(6{,}000\times148.5)}{33{,}000}$$

$$=54 \text{ horsepower}$$

As the lifting of the load utilizes 54 horsepower and the engine develops 60 horsepower, the efficiency is $54\div60=90$ per cent.

Ques. 37.—What load will break a white oak timber 10 in. $\times$ 14 in. and 15 feet between the supports, if the load is equally distributed along the length? (M. M., 10, Jan.)

Ans.—When the load is uniformly distributed upon a beam supported at both ends, the total load required to break the beam is found from the formula, $W=\frac{16\,S\,I}{L\,D}$. In this, $W=$the total load in pounds coming upon the beam, $S=$unit strength per square inch of the wood, which may be taken as 8,500 pounds for white oak; $I=$the moment of inertia of the cross-section of the beam, which is presumed to be placed with its 14-inch cross-dimension vertical; and L and D are, respectively, the length and depth of the beam in inches which, in this case, are $15\times12=180$ inches and 14 inches. If $b=$the breadth of the beam $=10$ inches, the moment of inertia may be found from $I=\frac{b\,d^3}{12}=\frac{10\times(14)^3}{12}$

$=2,287$. Substituting in the formula, $W=\frac{16\,S\,I}{L\,D}=\frac{16\times8,500\times2,287}{180\times14}$ $=123,425$ pounds. This is the total load required to break the beam. Since it is uniformly distributed, the load per running foot will be $123,425\div15=8,228$, say 8,000 pounds (or 4 tons) per running foot.

Ques. 38.—There are three airways in a mine, *A* being 3,000 feet long and 6 ft.×5 ft.; *B*, 4,000 feet long and 6 ft.×6 ft.; *C*, 2,000 feet long and 5 ft.×5 ft. The total quantity of air passing in the three airways is 75,000 cubic feet per minute. What is the quantity passing along each? (M. M., 10, Apr.)

Ans.—Assuming that the splits start from the same point and that the pressure is the same at the mouth of each, the quantity passing in each will be proportional to $a\sqrt{\frac{a}{s}}$ in which a=the area of the cross-section of each entry and s=the rubbing surface, which in turn is equal to the perimeter multiplied by the length. The above expression must be calculated separately for each one of the three splits.

For *A*, $a=6\times5=30$ square feet, and $s=2\times(6+5)\times3,000=66,000$; for *B*, $a=6\times6=36$ square feet, and $s=2\times(6+6)\times4,000=96,000$; and for *C*, $a=5\times5=25$ square feet, $s=2\times(5+5)\times2,000=40,000$. Substituting these values in the formula first given above:

Split *A* is $a\sqrt{\frac{a}{s}}=30\sqrt{\frac{30}{66,000}}=$ .6396

Split *B* is $a\sqrt{\frac{a}{s}}=36\sqrt{\frac{36}{96,000}}=$ .6971

Split *C* is $a\sqrt{\frac{a}{s}}=25\sqrt{\frac{25}{40,000}}=$ .6250

1.9617

The volume of air circulating in each one of the three airways is in the ratio that each one of the three quantities just determined bears to the sum of these three quantities. Then the amount circulating:

In split *A* is $\frac{.6396}{1.9617}\times75,000$

$=24,453$ cubic feet

In split *B* is $\frac{.6971}{1.9617}\times75,000$

$=26,652$ cubic feet

In split *C* is $\frac{.6250}{1.9617}\times75,000$

$=23,895$ cubic feet

Total, 75,000 cubic feet

Ques. 39.—If water weighs 62.5 pounds per cubic foot, and steam at atmospheric pressure has 1,640 times the volume of water, what weight of steam would be used per hour by a pair of engines, 30-inch cylinders and 5-foot stroke, making 30 revolutions per minute, and discharging steam at atmospheric pressure? (H. E., 14, Apr.)

Ans.—The piston speed is equal to twice the number of revolutions per minute (there are two strokes for each revolution) multiplied by the length of the stroke, or $2\times30\times5=300$ feet per minute. The volume displaced per minute is twice (there being two cylinders) the piston speed in inches per minute multiplied by the area of the cylinder in square inches, the whole being divided by 1,728 to reduce the cubic inches thus obtained to cubic feet. Expressed fractionally, volume per minute

$=\frac{2\times(300\times12)\times(30^2\times.7854)}{1,728}$

$=2,945.25$ cubic feet

The question assumes, although it does not so state, that there is no back pressure, compression, etc., and that, consequently, the piston displacement as calculated above is equal to the volume of discharged steam. This steam is stated to weigh 62.5 pounds for 1,640 cubic feet. Hence, to find the weight of steam used per hour, multiply the piston displacement per minute by 60 and then by $\frac{62.5}{1,640}$. Thus, we have weight of steam per hour

$=\frac{2,945.25\times60\times62.5}{1,640}$

$=6,734+$ pounds

Ques. 40.—We have a tank full of water in the morning when we commence work. We are using 1,100 horsepower per hour; how long will it take to empty the tank? The tank is 10 feet in diameter and 10 feet deep. (H. E., 12, Jan.)

Ans.—Assuming that each horsepower requires the evaporation of 34.5 pounds of water per hour, 1,100 horsepower will require $1,100\times34.5=37,950$ pounds. The capacity of the tank is equal to the area of its base multiplied by its height, or $(10^2\times.7854)\times10=785.4$ cubic feet. At 62.5 pounds per cubic foot, this volume of water will weigh 49,087.5 pounds. This will last $\frac{37,950}{49,087.5}=.773$ hour $=.773\times60=46+$ minutes. In practice, this quantity of water should last longer than this.

Ques. 41.—What is the breaking strain and safe working load for a good steel rope $1\frac{1}{4}$ inches in diameter? (M. M., 20, Apr.)

Ans.—The following table gives the breaking strain (first figure) and safe working load (second figure) of steel rope $1\frac{1}{4}$-inch diameter:

	6×19	8×19	6×37
Crucible cast steel	38-7.6	34-6.8	34-7.0
Crucible cast steel, extra strong	43-8.6	38-7.6	39-8.0
Plough steel	47-9.4	43-8.6	44-9.0
Plough steel, extra strong	56-11	46-9.2	46-9.2

All of these are "good steel" ropes within the meaning of the question, and the breaking strain and safe working load varies between 34 tons and 6.8 tons for the weakest to 56 tons and 11 tons for the strongest. For use as a hoisting rope, the choice would usually be made of 6×19 rope, either the crucible cast-steel with a total strength of 38 tons, or the extra strong crucible cast-steel with a total strength of 43 tons.

Ques. 42.—Find the safe working load of a $\frac{3}{4}$-inch, extra-strong, cast-steel hoisting rope having six strands and 19 wires? (H. E., 5, Apr.)

Ans.—Questions such as this relating to the strength of manufactured articles are far better answered by reference to the catalogs of the leading makers than by attempting to remember an arbitrary formula. While the various manufacturers have their trade names, more or less distinctive, for the sundry grades of wire rope, they, with one exception, agree on the strengths. These for the four kinds of steel used are, respectively, for $\frac{3}{4}$-inch rope, 6×19; crucible cast-steel, 17.5 and 3.5; extra-strong, crucible cast-steel, 20.2

and 4.04; plough-steel, 23 and 4.6; and extra plough-steel, 26.3 and 5.3. The first figure is the breaking strain in tons and the second, the working load in tons; estimated as one-fifth the breaking strength. From this the safe working load for a $\frac{3}{4}$-inch, 6-strand, 19-wire, extra-strong, crucible cast-steel rope appears to be 4.04, say 4 tons.

Ques. 43.—A mine is ventilated by three splits of air, *A*, *B*, *C*; *A* taking 2,500 cubic feet per minute; *B* 1,500 cubic feet per minute; and *C* 2,000 cubic feet per minute, out of a total of 6,000 cubic feet. What will each split take if the total ventilation be increased to 75,000 cubic feet per minute? (M. M., 4, Jan.)

Ans.—Since the length and cross-sections of the airways are unchanged each split will pass the same proportion of the total air that it did at the outset. That is, the volume of air will be increased in each in the ratio of $75{,}000 \div 6{,}000 = 12.5$. Hence, the volume of air passing will be

In split *A*,
$2{,}500 \times 12.5 = 31{,}250$ cubic feet
In split *B*,
$1{,}500 \times 12.5 = 18{,}750$ cubic feet
In split *C*,
$2{,}000 \times 12.5 = 25{,}000$ cubic feet
$6{,}000 \times 12.5 = 75{,}000$ cubic feet

Ques. 44.—What will be the velocity of wind in miles per hour when 6 pounds of powder has been fired on the air-current; the entry is 6×8, the hole has been tamped with solid tamping, 3 feet. Friction is not taken in this case. (First-Class Mine Managers' Examination, Springfield, Ill., July 22, 1912.)

Ans.—This question has been inserted in response to the requests of numerous readers. We frankly admit that we have not the slightest idea what it means, and seriously question our ability to answer it if we did.

Ques. 45.—A siphon has its short leg, 10 feet vertical, and long leg, 20 feet vertical, and is 6 inches in diameter, with a total length of 100 yards. Find the flow in gallons per hour, allowing for frictional resistance. (M. M., 12, Apr.)

Ans.—The effective head is $20 - 10 = 10$ feet. The length of the line is $100 \times 3 = 300$ feet. The head per 1,000 feet is $(10 \times 1{,}000) \div 300 = 33\frac{1}{3}$ feet. The diamcter of the pipe is 6 inches $= \frac{1}{2}$ foot.

The formula used in solving Ques. 13 applies here and we have,

$$D = .89\sqrt{d^5 h} = .89\sqrt{\left(\frac{1}{2}\right)^5 \times 33\frac{1}{3}}$$

$$= .89\sqrt{\frac{100}{32 \times 3}} = .89\sqrt{1.0416}$$

$= .9078$ cubic foot per second

This is equal to $.9078 \times 60 \times 60 = 3{,}268$ cubic feet, or $3{,}268 \times 7.48 = 24{,}444$ gallons per hour.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Steam, Its Generation and Use. Nearly every engineer owns or has heard of a former book of this title published by the Babcock & Wilcox Co., 85 Liberty Street, New York City. The original volume contained much information on water-tube boilers and matters pertaining to steam generation, but that book is out of date compared with the one recently received from that firm. It contains 335 pages, including index and many half-tones. Besides a history of the generation of steam and the water-tube boiler, there are many technical subjects treated, which supply a large amount of useful data that is necessarily referred to by steam engineers and steam users. There is a discussion on Heat and Its Measurements; Boiler Feed Water; Steam Table; Analysis of Flue Gases; Determination of the Heating Value of Fuels; Combustion of Coal, Oil, Gas, etc., and their relative heating values; the Efficiency and Capacity of Boilers; Care of Boilers; Flow of Steam Through Pipes and Its Calculation. These are but a few of the numerous subjects which have particularly interested the reviewer in looking through this book, but there are others which warrant putting in a requisition for one.

Application of Electricity to Mines. W. H. Patchell, well known among English electrical and mechanical engineers, has written a book on the "Application of Electrical Power to Mines and Heavy Industries." In 1904 Mr. Patchell was a member of the Home Office Departmental Committee on the Use of Electricity in Mines, an important position, since this committee formulated rules which govern the use of electricity in the coal mines of the United Kingdom. The book contains 329 pages of text, many half-tones, charts, and inserts, and is the outcome of a series of lectures delivered at the University of London, King's College. The book is divided into 12 chapters, as follows: Electricity in Mines; Cables; Coal Cutters; Haulage Gears; Rating of Haulages; Winding Engines; Electric Winders; Ventilation and Air Compression; Pumping; Rolling Mills; Machine Tools and Cranes; Electric Welding and Furnaces. D. Van Nostrand Co., New York, publishers. Price $4 net.

Mineral Deposits. Prof. Waldemar Lindgren, for many years with the United States Geological Survey, and now Professor of Economic Geology in the Massachusetts Institute of Technology, has written a book entitled, "Mineral Deposits." There are 30 chapters in this book, containing 883 pages of printed matter and 257 illustrations. An attempt to give an entire review of the book would be an unnecessary task, since Professor Lindgren is so well known in this country from his former writings, and his position is a guarantee that whatever he advances will be substantiated by the observations of others as well as his own. Professor Lindgren, like other modern geological writers, has a tendency to be verbose, in that he gives his own observations and those of nearly every one else who has written on the subject. As another step toward placing ore deposits on a scientific basis this book is invaluable. To the reviewer it seems an impossibility for a present-day mining engineer to make an intelligent report on a prospect or working mine without a

knowledge of others' observations. The book is printed by McGraw-Hill Publishing Co. Price $5.

Study of Igneous Rocks. George Irving Findlay, Ph. D., Assistant Professor of Geology, has compiled a book of 228 pages which is called "Introduction to the Study of Igneous Rocks." This is a classy little book with colored plates of rock sections, and presupposes an acquaintance with rocks such as is gained in the first year's work in geology. There are chapters on the Determination of the Igneous Rocks in Hand Specimens; the Movement of Light in Crystals; the Method of Describing Rocks; the Quantitative Classification of Igneous Rocks; the five primary divisions in this case being dependent upon different ratios between the salic and ferric minerals; to wit, Persalane, Dosalane, Selfemane, Dolemane, and Perfemane. If our memory does not fail us some one in the Far West made the statement that these kinds of caramels were delicious rocks, and by so doing participated the geological scrap between Tomasco Bendigo and Domalkali Someran, which took place February 27, 1909, in San Francisco. Tomasco won in the seventh round by a well-placed abracadabra to the hierophant. The book is printed by the McGraw-Hill Publishing Co., and costs $2 net.

Hendricks' Commercial Register. The twenty-second annual Revised Edition of Hendricks' Commercial Register of the United States for Buyers and Sellers has just been issued. It is the most complete work of its kind in existence. Its aim is to furnish complete classified lists of manufacturers for the benefit of those who want to buy as well as for those who have something to sell. It covers very completely the Architectural, Engineering, Electrical, Mechanical, Railroad, Mining, Manufacturing and kindred trades and professions. The present is the most complete edition of this work so far published. The twenty-first edition required 122 pages to index its contents, while the twenty-second edition requires 138 pages. The total number of classifications in the book is over 55,000. An important feature of the Commercial Register is the simplicity of its classifications. They are so arranged that the book can be used for either purchasing or mailing purposes. The value of the Commercial Register for purchasing purposes is not confined to its complete classifications alone. It gives much information following the names of thousands of firms that is of great assistance to the buyer and saves the expense of writing to a number of firms for the particular article required. This information is not found in any other similar publication. The trade names of all articles classified in the book are included, as far as they can be secured. The book is revised, improved and issued annually. The price is $10, and S. E. Hendricks Co., 74 Lafayette Street, New York City, are the publishers.

Volume No. III, Mining World Index of Current Literature, has been published. This is for the first 6 months of 1913, and is an international bibliography of mining and mining sciences compiled for the weekly issue of the *Mining and Engineering World*, of Chicago. It is by George E. Sisley, associate editor of that journal, and will be found very useful to those seeking information on special subjects relating to mining and metallurgy.

It is divided into 17 chapters, as follows: Gold, Copper, Lead, Iron and Steel, Alloys, Common Metals, Uncommon Metals, Non-Metals, Petroleum, Stones, Economic Materials, Mines and Mining (2 chapters), Mills and Milling, Power and Machinery, Miscellaneous.

There is an author's and subject index. Price $2.

Safety in Coal Mines, by Daniel Burns, Professor of Mining, Royal Technical College, Glasgow, 150 pages, illustrated, $1 net. Due to the new requirement imposed by the new Coal Mines Act on mining men in the United Kingdom, the need for some book on elementary scientific training in coal mining becomes apparent. Mr. Burns begins his book with the fundamental facts of science such as, the physical and chemical changes, matter, weight, atoms, Boyle's law, etc. He takes up in detail the constituent elements of mine gases; namely, hydrogen, oxygen, nitrogen, carbon, and sulphur. The greater portion of the book, however, is devoted to mine gases themselves, giving their tests, causes of occurrence, etc. Air measurement is discussed thoroughly, and finally the subject of safety lamps is treated, giving the requirements of a safety lamp, the necessity of a clean gauze and the approved types of lamps.

West Virginia Geological Survey. Detailed County Report on Monongalia, Marion, and Taylor counties, published under date of September 1, 1913, the largest volume yet issued by the Survey, containing 844 pages + XVII with 37 plates of illustrations and 11 figures in the text, and a case of 3 maps (Soil, Topographic, and Geologic) of the entire area. In addition to the detailed study and description of all the rocks, coals, limestones, clays, minerals, soils, streams, and industries, with hundreds of oil- and gas-well records, coal analyses, etc., occurring within the area and given in this Report, the geologic map gives the structural contours on the Pittsburg coal, and thus is very valuable to any one interested in coal, oil, or gas, in showing the exact positions of all the anticlines, synclines, and structural terraces.

The suggestions of Ray V. Hennen, the author of the Report, regarding the location of prospective oil and gas territory, which have heretofore been so frequently verified, are very full and complete in this report. Price, with case of maps, delivery charges paid by the Survey, $2.50, but in combination with other publications, see the general list of the publications of the West Virginia Geological Survey, Morgantown, W. Va. Extra copies of the Topographic Map, 50 cents, and of the Geologic and Structural map, $1 each.

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

Owing to the incompleteness of the answers submitted to Ques. 35, in the September issue, it is again presented for further replies.—Editor.

35. What would be the resultant gases in the air of a mine after (1) an explosion of gas and coal dust, (2) the detonation of dynamite, and (3) an underground fire? What is the nature of the gases in each case, their effect on life, and the method of dealing with them?

43. A fan driven by an electric motor produces 150,000 cubic feet of air per minute, 4 inches water gauge. The efficiency of the motor is 90 per cent. On the switchboard the voltage is 600 volts, and the ammeter reads 185 amperes. What is the efficiency of the fan?

44. What is the essential difference in composition between bituminous, semibituminous, and anthracite coals? Assume that the former and latter are being burnt in open, separate grates, and state the difference you can detect by burning.

45. A seam of coal dipping 12 degrees is thrown down 200 feet by a vertical fault. A slope is started from the top of the downthrow and cuts the seam 400 feet horizontally from the fault. Required the length and dip of slope.

Answers for Which Prizes Have Been Awarded

Ques. 36.—A deep mine is dry and dusty. Discuss briefly the best method of keeping down the dust, and state how this may influence the method of working.

Ans.—Coal dust is produced primarily at the working faces by the operations of mining and blasting; secondarily, through loss in haulage and disintegration by chemical action and pressure of the overlying strata. The method that would be the most successful in keeping it down would be that which would reduce it to a harmless condition at the places where it is primarily produced.

To render the dust harmless it must be reduced to a condition in which its projection into the mine atmosphere would be limited to the least possible amount or practically prevented, and the inflammable gases in its physical composition be removed by chemical action.

The first step to be taken for the mine in question would be a thorough dampening of the dust-laden districts with a substance that would exert both a physical and chemical action upon the dust. Such a substance would be that given by Capt. T. H. Edwards, M. E., of Golden, Colo., consisting of a solution of 1 part of sodium chloride (common salt) in 100 parts of water, making practically a 1 per cent. mixture of common salt. The salt, having a great affinity for water, retains it under conditions that would otherwise result in its rapid evaporation, thus reducing the dust to a condition in which it cannot be projected into the atmosphere and carried to points of danger by the air-current. The chloride of the salt acts chemically upon the dust and liberates the inflammable gases of the composition, gradually, and thus renders them harmless by dilution.

The next step would be to load out the dust in cars so constructed as to allow no loss through filtering in haulage. The entire mine should then be again dampened and be kept in that condition by frequent use of the solution.

The most important places at which efforts should be made to render the dust harmless are at the working faces. The largest percentage of coal dust is produced by mining machines which require, for their most effective work, a dry place. This condition may be overcome in two ways: First, by the substitution of pick for machine work, which would change the method of work but which is positive in its results; and secondly, by the projection of a dampening solution upon the mining face while the machine is in operation and thus attempt to render the dust harmless at the moment of its production.

In blasting, the least shattering approved explosives should be used;

the minimum charge for an effective shot; the proper placing and tamping of holes, and the firing of shots by experienced and trustworthy men at times when the employes are out of the mine. Sufficient time should be allowed between successive shots to permit of a subsidence of the results of the discharge.

exception of the necessary entries for haulage and airways, and the pressure of the overburden is concentrated, in its action, upon the working faces and the extracted area.

I. C. Parfitt

Jerome, Pa.

Second prize, Oscar Stickman, FitzHenry, Pa.

Economy in cost can be secured by reducing the number of sets to a minimum. This is done by spacing them at distances suitable to the roof condition and using lagging *c c*, extending from collar to collar.

As timber on any haulage road is an element of danger, to reduce this as much as possible the legs *B B* should

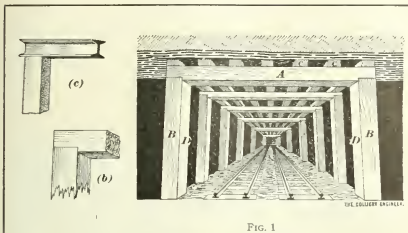


Fig. 1

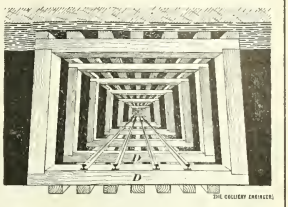


Fig. 2

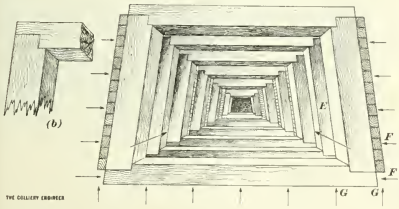


Fig. 3

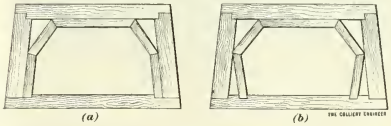


Fig. 4

The ventilation should be ample, in splits, and well maintained at all times.

The secondary conditions of dust production are as important in the effects produced as are the primary, and should receive more attention than has heretofore been accorded them. Large areas of coal surfaces are left exposed to chemical action and the pressure of the overburden for too long a period of time by our general system of development, and as a result the coal becomes broken and rendered more brittle, and large quantities of dust are produced in this way.

To overcome such a condition a method of retreating work should be adopted by which a limited coal surface is left exposed, this being the working surfaces with the

Ques. 37.—Sketch and describe how you would timber a main level (*a*) with a weak roof, strong sides and floor; (*b*) with a weak roof, strong sides, and weak floor; (*c*) with a strong roof, weak sides, and weak floor. Pay due regard to cost, and assume the seam to be a flat one.

Ans.—Fig. 1 shows the method to be adopted to meet the conditions of a weak roof with strong sides and floor. As the pressure is vertical, the stress will be exerted upon the collar *A* which should be as short in length between the legs as is suitable for the haulage, as the strength of a collar of given depth and breadth is inversely as its length. To meet this requirement the legs *B* should be set so that they will have a batter not exceeding 2 inches to each foot of height.

be cut into the sides so that their outer or exposed faces *D* are flush with the sides of the entry. This will reduce the possibility of their being knocked out in case of a wreck.

If the mine be extensive it would be more economical to have the collars *A* of steel I beams and the legs *B B* of masonry or concrete; for, while the initial cost for material and erection would be greater their useful existence would be so much longer that the final cost would be less. The details of the wood timber joint for collar and leg are shown at (*b*); for I beams and concrete or masonry pillars at (*c*). When steel and masonry are used the batter for the pillars is not used as it would detract from their strength. In other respects the method of erection for either material is similar.

The method of timbering suitable to meet the conditions of a soft roof and floor and stronger sides is shown in Fig. 2. The collars, legs, and lagging are the same as required for the first condition and should be similarly placed. The legs in this case should, preferably, be of wood, as they are to serve the purpose of braces to the mud-sills *D D*, which are notched to fit the bottom of the legs, as shown at (*b*), and extend across the entry from side to side. The mud-sills are used to prevent the upheaval of the bottom from the pressure of the roof and sides, which pressure being applied to the sills at their ends is distributed throughout their entire length with graduated decreasing force from the ends toward the centers. If the bottom be excessively soft, additional mud-sills may be used by needling the ends into the sides in the spaces between the legs. For such a condition lagging may also be used on the bottom, as shown, but this is not usually done.

Fig. 3 shows the method to be adopted with weak sides and bottom and strong roof. Collars, legs, and mud-sills are used, but the collars are notched differently for contact with the legs from that shown in the previous conditions.

In this case the roof requires no support and the collars are used as braces to assist the legs in resisting the side pressure. The notching as shown at *b* is made suitable for this purpose. As the legs are subjected to a transverse pressure they should be of a minimum length suitable to other conditions.

The legs are subjected to a lateral stress from the weak sides, as shown by the arrows at *F F*, and the mud-sills to an upward vertical transverse stress, as shown by the arrows at *G G*. The resultant of these two forces will be, in direction and intensity as shown by the arrow at *E* if the forces *F* and *G* be equal, or at a different angle and intensity according as the forces *F* and *G* differ in magnitude.

To meet this resultant the mud-sills should be notched to fit the leg in the manner shown in Fig. 3, as the effect of the pressure will be to make the joint tighter or to press them closer together. Lagging is used at the back of the legs to distribute the pressure and to prevent the falling of material from the sides into the roadway.

If the side and bottom pressures be excessive the mud-sills and legs are reinforced by braces, as shown in Fig. 4. The material in this case should be of wood, except possibly the collars.

I. C. Parfitt

Jerome, Pa.

Second prize, W. W. Hunter, Clinton, Ind.

Ques. 38.—Recently the steel wire rope at an anthracite mine pulled out of the ordinary socket with its usual rivets and clamping rings. Give the probable cause of failure and indicate by sketch the clamping you consider best.

Ans.—The most probable cause of the rope pulling out of its socket with its usual rivets and clamping rings may have been due to excessive jerking when lifting the load from the bottom of the shaft. The portion of the rope adjacent to the socket is subjected to so much vibration whereby the nature of the wire is changed from a fibrous to that of a crystalline character, that it is necessary to periodically recap the rope. Recapping has another important object, that is, the interior of the rope can then be thoroughly examined, also a fresh piece of the rope can be brought to bear on the sheaves when the cages are at their various resting places.

Another cause of failure of the rope could have been the driving of a

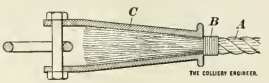


Fig. 5

spike through the rope in the making of the rivet holes, thereby damaging the strands as well as the interior of the rope.

The capping I would consider best would be the solid or the white-metal capping. This form of capping is shown in Fig. 5. It consists of a conical-shaped socket forged from a solid piece of steel, with a composition of white metal run around the wires to form a cone, fitting perfectly into the conical-shaped cap. This capping is stronger than the rope itself, tests having proved that the rope has been known to break first. It is also considered to be the simplest, strongest, and safest capping known. The process of capping is simplicity itself, and can be done in about a quarter of the time that it takes with other forms of cappings.

The cap or socket is threaded on to the rope, and the rope is frayed out almost the length of the socket, but is wrapped with wire, as shown in Fig. 5. The wires of the rope in the socket are straightened and slightly hooked at the ends, and thoroughly cleaned with hydrochloric acid to remove the oils with which every rope is covered. The socket is then completely filled in with white metal, consisting of 60 per cent. lead, 30 per cent. tin, 9 per cent. antimony, and 1 per cent. bismuth. The bismuth lowers the temperature of fusion, and is supposed to give a slight expansion in cooling, while the antimony adds to the hardness.

The objection might be made that the temperature of the molten metal might injure the wires, but steel wire, if it has not been previously hammered or worked, is not affected up to a temperature of 900° F., while the temperature of the molten mixture never exceeds 500° F. Before the cap is placed on the rope it is slightly heated, also the wires after cleaning should be heated, and no two wires must be permitted to be together. A resinous dust is blown in among the wires to insure adhesion of the metal about to be poured in. The cap should be allowed to cool an hour after the metal has been poured before being put into use.

The result is an ideal socket for a winding rope, and one able to cope with a heavy load.

Will W. Hunter

Clinton, Ind.

Second prize, William Condie, Yukon, Pa.

NEW MINING MACHINERY

The Breast Turret Coal Cutters

The demand for coal cutters which would increase the output and decrease the cost of mining, and also increase the safety of mining has brought out some new ideas worthy of comment. In coal mines where the roof is weak, and the rooms are driven narrow, say 12 to 14 feet in width, undercutting is carried on with ordinary breast mining machines. In such cases, quite a heavy charge of powder is used and this has a tendency to weaken the roof, and increase the danger from blown-out shots, besides breaking a large percentage of the coal to slack.

To overcome these difficulties, the breast turret coal mining machine has been designed. As manufactured by the Jeffrey Mfg. Co., of Columbus, Ohio, it consists of the Jeffrey breast machine mounted on a turntable truck. The machine is pivoted in the center of the turntable, which is placed on rollers to reduce the friction in revolving around its central pivot. The machine shown in Fig. 1 is mounted on a home-made truck and frame, yet it is cutting in a 7-foot bed and has done remarkably good work; in fact, in connection with a gathering locomotive to haul it from place to place, it has cut as many as 36 places in 10 hours.

The height of the frame on which the machine is pivoted varies; and in some cases it is supplied with a motor for moving it from place to place. The average number of places cut per day, is from 20 to 26. The machine when entering the room is brought up to the face and the first cut is made at the left-hand rib. Where the cutting is soft, no jacks are needed, as the truck is either blocked or the brake set to prevent the truck from moving when the cutter frame is pushed into the coal. It usually requires three or four cuts in each place. By having the cut made in the center of the seam, the powder required for breaking the coal is usually two small shots for the top and three shots for the bottom bench.

Where the breast machine is worked in conjunction with a locomotive, it requires two men to operate the combination, one man to run the locomotive, and the other man to operate the machine. In mines where the cutting is done at night, the locomotive is generally used during the day for gathering the coal; consequently, the only charges for the locomotive would be depreciation and the cost of repairs.

When it is considered that an ordinary breast mining machine could only cut from six to eight places per shift, and required two men to operate it, it will be seen that the output is increased over 300 per cent. with the breast turret machine. This arrangement reduces the number of machines required to do a certain amount of work together with the necessary labor for such machines.

In coal seams where there is a parting at or near the top of the seam, the Jeffry top cutting machine has been used to advantage. This machine, shown in Fig. 2, consists of a narrow cutter bar pivoted on an adjustable turret ring, so as to swing and make a cut 20 feet in width.

In cutting the room, the cutter bar is swung so as to cut from the right toward the left-hand rib. The machine, when entering the room, has its cutter bar in the longitudinal position of the truck, and when thus brought to the face, the front and rear jacks are set. The machine is then started and the cutter bar swings from the right toward the left.

The machine is made adjustable to conform to the irregularities in the parting which is to be cut out.

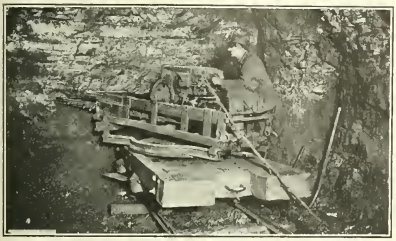


Fig. 1. Breast Turret Coal Cutter

Fig. 2. Top Cutting Machine

This machine is adaptable to partings, consisting of rash, slate, or bone coal, which, when cut, can easily be gobbed, and leave the coal clean when broken. The machine can easily cut from 15 to 18 rooms a day, and it has cut a 20-foot room in 8 minutes. The truck is provided with a self-propelling arrangement for moving the machine from room to room.

Portable Air Compressors

The Sullivan Machinery Co., of Chicago, Ill., have devoted much time and thought to the design of portable air compressors, direct-connected to a motor and mounted on a truck for use underground.

The value of small portable independent air compressors will be appreciated, particularly by coal mine owners who have electric power, low seams or undulating floors, for there are many operations which could be performed more economically if air power were available. Such instances include the operation of coal pick machines, air rock drills, or hammer drills, in places where the development is to be permanent. One of these small compressors will provide enough air to operate a coal pick machine, or a post puncher, one or two rock drills, or several hammer drills.

The portable compressor shown in Figs. 3 and 4 is a single-stage machine with the main working parts enclosed in a tight housing. An unloading device on the air inlet of the machine prevents waste of power when the air is not being used. The poppet valves are arranged radially with the axis of the cylinder so that the ports leading to them are short and direct. This arrangement makes clearance losses small and the efficiency of the cylinder high. The motor drives the compressor by means of an internal gear on the flywheel, which meshes with a pinion on the end of the motor shaft. An air receiver of adequate capacity is securely fastened to the cast-iron base of the truck, and the air cylinder is cooled by means of water in an open hopper jacket which is part of the cylinder. This method of cooling has been found satisfactory, and does away with the circulating pump.

The outfit shown has a 10″ × 10″ air cylinder and compresses 181 cubic feet of free air to 80 pounds

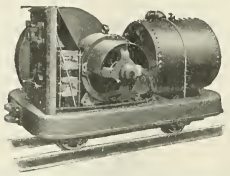


Fig. 3. Front, Portable Air Compressor

at 200 revolutions per minute. Complete, the apparatus shown weighs about 7,200 pounds, is 8 feet long and about 5 feet wide.

Machines of this kind have been in use about two years at the Midway mine of the Chicosa Fuel Co., at Rouse, Colo., supplying power to two Sullivan pick machines, which are used in cutting rooms and driving entries. The compressor is started at the beginning of a shift by a pump man, and no one goes near the machine again until the end of the shift. The unloading device reduces waste of power when the punchers happen to be idle. The air is supplied at 80-pound pressure through two 2-inch pipe lines about 400 feet long each.

The two Sullivan pick machines cut from 80 to 100 linear feet of face per day. Since they were installed, the percentage of lump coal has increased about 20 per cent., compared with the coal won by shooting off the solid. Rooms are being worked with the punchers, which could not be touched before because of bad roof. Attempts to shoot from the solid in these places usually resulted in blowing out the props, and the whole roof then caved.

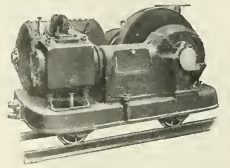


Fig. 4. Back, Portable Air Compressor

The use of the compressor outfit at this mine has resulted in important economies, since a compressor at the surface would have entailed a length and cost of piping which would have been almost prohibitive.

The Sullivan company is sending 6 semiportable compressors to one large company in Colorado, which will operate column coal cutters.

Rice Gasoline Rock Drill

Recently Mr. John V. Rice, Jr., a man well versed in the requirements of a rock drill, has invented a reciprocating percussive gasoline rock drill which in a six-months trial is said to have compared favorably with the modern percussive compressed air drills.

A percussion rock drill, to be a successful machine, must move the piston forward and strike a hard, direct blow; the drill bit must be turned on the return stroke, so as not to strike in the same place twice in succession, or the hole will groove and the bit fitcher; the return stroke must be quick and be cushioned, so as not to injure the backhead of the cylinder. All of these points Mr. Rice seems to have considered and obtained by making use of two cylinders having a common piston rod, with individual pistons for each cylinder, as shown in Fig. 5.

Make and break spark plugs for each cylinder are tripped and fired by the pistons alternately. The firing of the rear cylinder drives the piston rod forward, the bit hitting the rock with all the force of an explosion of gasoline. The front cylinder then fires and the piston is sent back to its first position, and then with the full force of an explosion, the drill is driven against the rock again.

These reciprocating operations continue indefinitely.

The pulsator is of the two-cycle

design (no valves used) and is fired at each stroke of the piston. The cylinders are water cooled by a pump operating simultaneously with the drill piston. The fuel and oil container is attached to the side of the drill and is adjustable with respect to the angle at which the drill is set. When running, the lubrication of the working parts is automatic.

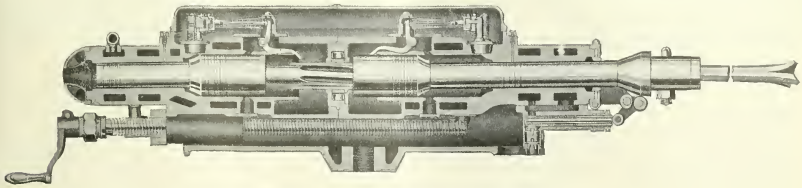


Fig. 5. Section Showing Gasoline Rock Drill

The drill strikes 600 blows a minute with a bit 24 feet long and drills holes from 1⅛ inches to 2¾ inches in diameter at any angle. The cutting speed is under the control of the operator, but when running at full speed the drilling is as rapid as the air or steam drills of equal cylinder size and weight. It operates for 10 hours on less than 3 gallons of gasoline when drilling continuously at the highest speed.

The cost of daily operation is estimated at $3.50 for drill runner, $2.50 for drill helper, 75 cents for gasoline, and 10 cents for lubrication. A total of $6.85.

The Manierre Car Loader

Any box-car loader at this date, appeals to coal shippers, and the Manierre Engineering and Machinery Co., successors to Ticknor-Manierre Co., of Milwaukee, Wis., have one which reduces expense and breakage in loading. The loader is a belt conveyer, pivoted so as to enter the side doors of a car, and by means of power derived from motors, is able to load from 6 to 8 tons per minute, according to the size of the conveyers and motors.

As 2 minutes are required to get the loader in and out of the car, to attach and detach the chute, and to change from one end of the car to the other, the time required to load is 2 minutes plus the actual time the coal is running, determined from the size of the conveyer and motor, and the capacity of the car. This, plus the average time to spot the cars divided into 60, gives the rate of loading in cars per hour. The loader is as good for coke as coal.

After the Fire

When the shops of the Flory Mfg. Co., of Bangor, Pa., were destroyed by fire on July 31, they had a large amount of work on hand and contracted for. Therefore, with unusual speed, temporary buildings were erected and new machinery installed, so as to fill contracts with least possible delay. The company has been, for some weeks, employing a full force and is taking care of all their business as before the fire.

Upon the completion of the new buildings, the machinery will be installed in them and the company will have better facilities than ever for turning out their specialties, including steam and electric hoists, boilers, etc.

TRADE NOTICES

Canadian Coal Plant.—The Roberts & Schaefer Co., Engineers and Contractors, Chicago, have contracted to construct a complete coal mining plant for the Brazeau Collieries, Ltd., of Toronto, Canada, at a price of approximately, $185,000. This plant will open up the recently acquired coal acreage of the Brazeau Collieries, Ltd., at Nordegg, Alberta, Canada. This company is owned jointly by McKenzie & Mann, who control the Canadian Northern Railway; Mr. Martin Nordegg, vice-president and managing director; and a firm of Belgian bankers, who are represented by Mr. Ernest Gheur, consulting engineer, and Mr. H. Prudhomme, their American representative, treasurer of the coal company.

The Canadian Northern Railway Co., has practically completed a line 160 miles long to Nordegg, at the site of the mines.

This plant will be one of the most extensive in the Canadian field, and will consist of a modern mine tipple with box-car loader; dump house from two slope coal mines, with conveyer delivering coal to tipple; complete boiler plant, including boiler coal conveyer; combined generator house and repair shop, including electric transformers; combined carpenter and blacksmith shop; warehouse; two mine fans; mine office building; boarding house; miners' wash house; two railroad track scales; commissary building; complete steam and water piping for the entire equipment, and all electric wiring.

The Roberts & Schaefer Co. have guaranteed to complete this entire installation in the fall of 1914.

Galveston Branch.—The H. W. Johns-Manville Co. now has three offices in Texas, viz., at Houston, Dallas, and Galveston. At the last named place, in a large brick warehouse will be consolidated the stock

for distribution to the different offices and throughout the Texas territory. The company plans to receive at this point, heavy shipments by coastwise lines from New York. The steadily increasing trade with Central and South America also makes Galveston a convenient point of distribution for their roofing, building materials, packings, pipe coverings, insulating materials, electrical, and asbestos goods.

Air Washers.—The American Blower Co., of Detroit, Mich., has purchased the entire air washer interests, including patent rights, of the McCreery Engineering Co., formerly of Toledo, Ohio, and later of Detroit, Mich. The McCreery company enjoyed a universal reputation as engineers and manufacturers of efficient air purifying apparatus, and the McCreery purifying, cooling, and humidifying equipment will hereafter be exclusively manufactured and sold by the American Blower Co., under their trademark, "Sirocco."

Removal.—W. R. McLain Co., advertising agents, who for many years have had offices at 524 Walnut St., Philadelphia, have removed to more commodious quarters in the Biddle Bldg., West Washington Square, Philadelphia, where they will continue to serve their rapidly increasing list of clients.

Catalogs Received

Northern Conveying Machinery Co., Milwaukee, Wis. The "Milwaukee" Loader, 18 pages.

The Industrial Instrument Co., Foxboro, Mass. Bulletin 81, Electric Pyrometers, 15 pages.

Albany Lubricating Co., 708 Washington St., New York. The Bearing, 16 pages.

Union Electric Co., Pittsburg, Pa. Mine Headlights, 12 pages.

Sullivan Machinery Co., 122 S. Michigan Ave., Chicago, Ill. Bulletin No. 58-N, Sullivan Small Air Compressors, 15 pages; Bulletin 66-H, Sullivan Rock Drills, 55 pages.

Ingersoll-Rand Co., 11 Broadway, New York. "Little David" Riveting Hammers, 7 pages; booklet, Calyx Bore Holes, 16 pages; booklet, The Story of the Butterfly, 20 pages.

Kolesch & Co., 138 Fulton St., New York. Catalog and Price List of Mining and Surveying Instruments, Materials, and Accessories. 336 pages.

National Tube Co., 1608 Frick Bldg., Pittsburg, Pa. "National Spring Plug Cock," 4 pages.

Rice Gasoline Rock Drill Co., 1510 Land Title Bldg., Philadelphia, Pa. Gasoline Rock Drills, 8 pages.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Hand Drills and Portable Compressors, 16 pages; Class "M" "Chicago Pneumatic" Corliss Type Steam-Driven Compressors, 11 pages.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Steam Turbines and Generators, 52 pages.

Mesta Machine Co., Pittsburg, Pa. Brief Description and Illustrations of the Plant and Product of the Mesta Machine Co., 47 pages; Mesta Blowing Machines, 8 pages.

Bausch & Lomb Optical Co., Rochester, N. Y. Bausch & Lomb Engineering Instruments, 20 pages.

Sylvester Co., Connellsville, Pa. The "Sylat" Timber Puller, 12 pages.

National Tube Co., Frick Bldg., Pittsburg, Pa. "National" Stationary and Marine Boiler Tubes, 7 pages; The Manufacture and Use of Shelby Seamless Steel Tubing, 39 pages.

S. F. Hayward & Co., 39 Park Place, New York. Circular, New Model 12 Westfalia Rescue Apparatus.

Orenstein-Arthur Koppel Co., Koppel, Pa. Catalog No. 900, 84 pages.

General Electric Co., Schenectady, N. Y. Drawn Shell Type Direct-Current Motors With Oil Ring Bearings, 11 pages; G-E Steam, Water, and Air-Flow Meters, 56 pages; Curtis Steam Turbines, 15 pages.

Baldwin Locomotive Works, Philadelphia, Pa. The Forty-Thousandth Locomotive, 27 pages.

Bristol Company, Waterbury, Conn. Bristol's Recording Instruments, Complete Set of Catalogs and Bulletins in special binder, with thumb indexes.

The Wm. Powell Co., Cincinnati, Ohio. Booklet Powell Grease Cups, 16 pages. Circular, Powell Union Composite Disc Valves.

Briquets of Coal and Naphthalene

Briquets are generally prepared by mixing coal with a proper agglutinating substance, tar being commonly used. But the price of tar is rather high, and when the coal used is of poor quality, the quantity of tar to be incorporated becomes too large and the net cost is prohibitive.

It has been tried, especially in Germany, to replace the tar by the naphthalene, which, although being comparatively expensive, has the advantage of having a larger agglutinating power than the tar. The naphthalene is melted in a boiler, then vaporized in a special apparatus by means of overheated steam. The vapors of naphthalene are then injected under the mass of coal to be treated, and the operation is regulated in such a way that the gases coming out from the coal do not contain naphthalene. The results obtained are very satisfactory: instead of 6.5 per cent. of tar to add to the coal, to obtain agglutination of a sufficient resistance, 4.5 per cent. only is required, when 3 per cent. of naphthalene has been previously applied.

Coal Used for Coke Making

The quantity of coal used for coke making in the United States in 1912 was 65,485,801 short tons, according to the United States Geological Survey. The coke produced from this coal amounted to 43,916,834 short tons, valued at $111,523,336, besides large quantities of gas, tar, ammonia, etc., as by-products from the 11,048,489 tons of coke produced in by-product ovens.

The Colliery Engineer

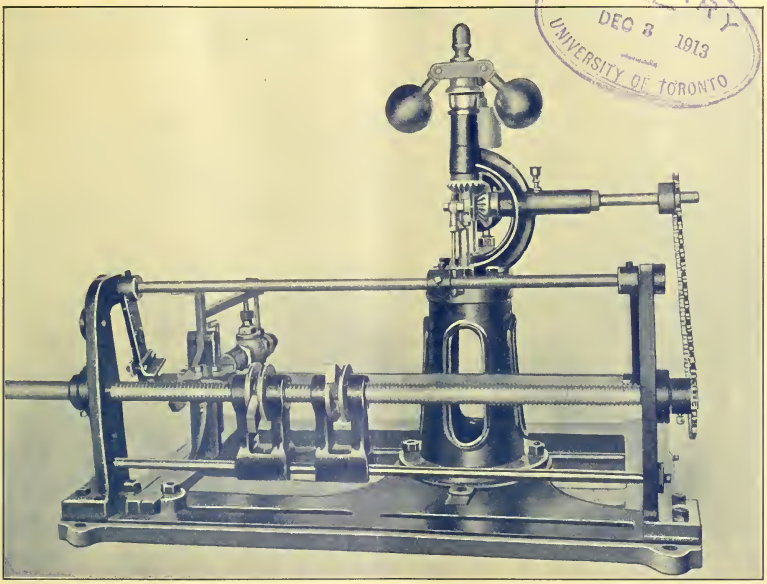
Formerly Mines and Minerals

ol. XXXIV—No. 5 DECEMBER, 1913 Scranton, Pa.

phabetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68

LIBRARY
DEC 3 1913
UNIVERSITY OF TORONTO



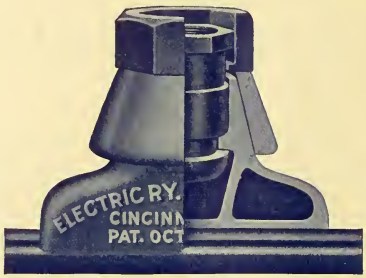
Improved Welch Safety

Those terrible accidents cannot occur if the Welch Safety is on your hoisting engine. Four hundred in use in the United States. Two hundred in use in Pennsylvania by large and progressive companies like—

D., L. & W. Coal Company - - Scranton, Pa. | The Pennsylvania Coal Company - Scranton, Pa.
The Lehigh Valley Coal Company - Wilkes-Barre, Pa. | The Lehigh Coal and Navigation Company - Lansford, Pa.
The Amalgamated Copper Company - Butte, Montana

These five companies have one hundred and thirty in use. They tried all other "Safeties," discarded them and adopted the Welch. The Welch Safety is simple—and unfailing, or it costs you nothing. Ask for complete details.

C. R. WELCH, P. O. BOX 578, PITTSBURGH, PA.



"SURE GRIP"

"Sure Grip" is not simply a trade name used to designate our particular brand of Trolley Clamps. It is also an absolute guarantee—it's a fact.

The "Sure Grip" Trolley Clamp is all its name implies.

It is so constructed that, once adjusted properly, it is simply impossible for it to work loose or to drop the wire.

This is but one of the features that has made the "Sure Grip" Trolley Clamps so popular in the mine field. Men in the workings feel absolutely secure when walking along passages where trolley wire is strung. They know that the wire **cannot** work loose and hang down, endangering their lives.

Made in all sizes from 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine and Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah (Office Atlanta) Cleveland
San Francisco Los Angeles
Seattle Portland, Ore.

HAZARD WIRE ROPE

FOR EVERY PURPOSE

HAZARD MFG CO.

WILKES-BARRE, PA.

NEW YORK 50 DEY STREET. PITTSBURG FIRST NTL BANK BLDG. CHICAGO 552 WEST ADAMS ST.

COPYRIGHT, 1913, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

For Coal, Coke, Mines and Minerals

Vol. XXXIV No. 5 DECEMBER, 1913 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1891

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE 13,500

TABLE OF CONTENTS

Editorial—
Warning—The American Mining Congress—The Anthracite Mine Cave Problem—Put the Blame Where It Belongs 263
Personals 266
Short Mountain Breaker, by William Z. Price 267
Williams Valley Mining Institute 270
Origin of Coal, by William Greeley Burroughs 271
New Coal Field Investigated 274
Coal Mining Institute of America 274
Madison Coal Corporation Exhibition 275
The Cost of Coal Mining, by E. W. Parker 281
West Virginia Coal Mining Institute 283
German Rescue Organization, by Bergassessor Breyhan 284
Panther Valley Mining Institute 286
Accident With a Benzole Locomotive 288
Gas Exhauster for Coke Ovens 288
Hydraulic Stowing at French Collieries 289
The American Mining Congress 290
Shaft-Gate Controlling Device 299
A Pressure and Velocity Meter 300
Electric Mine Haulage, by Eric A. Lof 301
Taxation of Anthracite 70 Years Ago 306
Kentucky Mining Institute 306
Practical Talks on Coal Mining—
Mechanics of Mining, 307—Mine Ventilation, 308—Electricity in Mines . 309
Book Review 311
Correction 311
Letter Box—
Compound Interest by Logarithms—Conveying Sand by Compressed Air—Tennessee Mining Law—A Few Pro's and Con's on Coke Manufacture—Pillar Drawing 312
Specifications for Lubricating Oil 314
Oxidation of Coal 316
Examination Questions—
Mine Foremen and Assistant Mine Foremen, Carbondale, Pa., June, 1913 317
Method of Tamping for Greater Safety in Blasting 321
Prize Contest 322
Obituary—
Col. Louis W. Fowell 324
Texas Coal Mining Outlook 324
Truesdale Breaker Record 324
New Mining Machinery—
The Largest Mine Locomotive Ever Built, 325—The Jeffrey-Drennen Adjustable Turret Coal Cutter, 325—"Bulldog" Die Stock, 327—A New Anemometer 327
Trade Notices 327
Catalogs Received 328
Squibs—
Nevada Elevation, 270—Coal Exports of United States and Other Countries, 306—Notable Colliery Record, 311—Pure Water, 314—Tread Mills, 316—Shooting Off the Solid, 321—Water Pressure 328

Warning

FROM now until warm weather approaches, care should be taken to water the entries of coal mines, and to keep them free from coal dirt and dust.

Fireclay, free from coal should be spread liberally on entries over which mules travel.

There are no better ways of guarding against coal-dust explosions than by keeping dry dust from accumulating on entries.

Particular attention should be given to coal-dust accumulations near the face of the headings, and wetting the dust at such places can do no harm. Dust explosions do not start instantly, as do powder or gas explosions, and if the dust is not where it will feed the flame of an explosion of gas or powder there can be no dust explosion. A new method recently suggested is to use external tamping; that is, place a shelf before the holes to be blasted, and on the shelf place pulverized stone dust. The blast then scatters the stone dust and stops the flame from extending any distance from a shot.

Bear in mind, if the flame reaches a dusty entry there is apt to be a catastrophe.

The American Mining Congress

THE Philadelphia meeting of the American Mining Congress, on October 20 to 24, inclusive, while not so large in attendance as many previous meetings, was a most successful one.

The comparatively large attendance of men engaged in coal mining and the opportunity such a meeting afforded for a clear understanding of the province of the organization, and its power in influencing the trend of affairs to the interest of all engaged in the mining industry, regardless of mineral produced, resulted in much good.

The object of the American Mining Congress is different from that of technical mining societies and institutes, and the organization in no way trespasses on their field of work.

Its object is to effect an organization of all persons engaged in mining, through which a campaign of education for the non-mining public, and especially for representatives in the national and various state legislatures, can be accomplished, with the view of molding legislation affecting mining so that while conserving the interests of all the people, it will not be irrational and burdensome on any branch of the industry.

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY ALL RIGHTS RESERVED

The papers read and discussed at the meeting related to the business or commercial side of the industry; and, the past and present policy of the national and of the several state governments toward mining propositions received great attention.

The necessity and advisability of concerted action by those engaged in all kinds of mining in preventing ill-considered and hurtful policies toward any branch of the industry inaugurated by misinformed officials, was strongly shown. At the same time rational methods of regulating the conduct of business was commended.

While all present realized it was not the function of the organization to take up purely local questions, it was its object to act on the broad questions or policies that affected any one of the branches of the industry as a whole.

The election of Mr. Carl Scholz, of Chicago, as President, and Messrs. W. J. Richards, of Pottsville, Pa., and M. S. Kemmerer, of Mauch Chunk, Pa., as members of the Board of Directors, gives the coal mining industry an important standing in the Congress, and is assurance to all engaged in coal mining that the influence of the organization can be made a powerful factor in establishing the commercial and legal status of the industry on rational lines, and in the prevention of irrational and mischievous laws or rules.

Every mining society of good standing in the country, as well as every man engaged in coal mining as an owner or managing official, should be connected with the organization and aid in making it a power for good to the industry.

The Anthracite Mine Cave Problem

THE difficulties in solving the anthracite "mine cave" problem, or, in other words, the problem of mining a maximum amount of the valuable and rapidly decreasing deposits of Pennsylvania anthracite, under the many cities and towns of the region in such a manner as to do least damage to the surface, or in case of damage, to provide a plan of compensation for damages that will be equitable to both surface owners and mining companies, is one that was thoroughly studied and reported on by a commission appointed by Governor Tener of Pennsylvania.

This commission was composed of men of great ability, and it is doubtful if a better qualified group of men was ever called on for such a peculiar public service. Their personal service in frequent and lengthy sessions for a period of over a year, during which time the individual members devoted many hours to the study of the question, both at and outside of the meetings, was given to the state as a free public service, the actual expenses only being paid by the state.

The report of the Commission made to the Governor was a voluminous, thorough, and able one, and the unanimous recommendation that the offer of the mining companies to pay at least one-half of the sum required to repair damages to property affected by mining when the value of the property was less than $5,000, and to sell to the surface owner whose property was worth over that amount sufficient pillar coal to protect his surface at a very reasonable figure, should have been accepted.

As there has been, as far as we know, no withdrawal of this offer, it may not be too late for property owners in affected sections of Scranton, and other towns, to take advantage of it. One reason why the offer was not accepted promptly was that a number of well-meaning men not informed in technical coal mining, coal geology, business conditions, and the laws of equity, opposed the plan. In addition, the opposition was strengthened by the work of politicians and others who had personal ends to further.

The difficulty of settling the matter has been increased by an editorial on "The Mine Cave Problem," in the *Coal Age* of November 8. This editorial was either written by one unfamiliar with facts as regards anthracite mining, or was a deliberate attempt to reflect on one or more prominent anthracite mine managers.

Advance proofs of the editorial in question were sent to several daily papers in the anthracite region, and the editorial was published in whole or part in some of them. The general newspaper men who published it accepted it in good faith, as the opinion of a competent technical writer, and are therefore not to blame for throwing into the controversy matter that tends to increase the difficulties of an equitable settlement of the question.

Briefly stated, the editorial referred to criticizes

1. The managements of the large coal mining corporations for "stolid indifference" to the infliction of danger on the property and lives of citizens through greed.

2. It refers to a "so-called Mine Cave Commission" maintained at an annual expense of $7,500 that after 2 years has accomplished nothing of a tangible nature.

3. It speaks of the extraction of pillars as "unconscionable robbing of pillars"—as if that operation was a criminal practice.

4. It refers to a recent decision of the Supreme Court of Pennsylvania in such a manner as to create a false impression of the decision. The salient sentence in this part of the editorial is: "The Supreme Court has held that surface support is an inherent right of the purchaser."

The first misstatement is an unwarranted libel on the able men directing the operations of the several companies. Men whose standing in the community, whose public spirit, and whose individual support in all things tending to be of real value to their several communities are notably high. These men have for years, as practical managers, been devoting their best thought to the solution of the troublesome question, and, in many instances have expended vast sums of money in remedial measures, some of which have, from time to time, during the last 20 years, been described in The Colliery Engineer.* No sane man acquainted with the gentlemen referred to will accuse

*Notwithstanding that under Supreme Court decisions there are many cases under which the mining companies are not liable for damages to surface property, the managements of some of the larger companies are, and have been, paying the *entire* cost for repairs to surface properties damaged by their mining operations.

them of "stolid indifference" to the troubles of their neighbors and townsmen. It is true that they have not always succeeded in averting trouble, but that was not because they haven't tried. The man who can mine coal without making a hole in the ground hasn't been born yet. Conditions over which the men at the operating heads of the large companies have no control, have in a number of cases damaged the surface. These instances immediately receive wide publicity, but the many other instances where they have succeeded in mining the coal and at the same time protecting the surface are known only to those who have enough technical mining knowledge to appreciate what has been done, and who have through interest in the subject investigated the matter.

The writer of the editorial was badly mixed when he referred to the "so-called Mine Cave Commission." The original Mine Cave Commission appointed by Governor Tener, we have shown, did "something tangible." It did a work that entitles the men composing it to the highest commendation, instead of implied abuse.

The local Mine Cave Commission of three men appointed by the Mayor of Scranton at an expense to the city of $7,500 per annum, in accordance with an act of the Legislature, has not been in existence 1 year. It has not accomplished "anything tangible" because it has no authority to do anything but examine the mine workings and report on conditions to the Superintendent of Public Works, and to draw a salary of $2,500 per year for each member.

"Unconscionable robbing of pillars." Does the writer of the editorial in the *Coal Age* class this offence as petit larceny, grand larceny, or burglary?

As to the recent decision of the Supreme Court, which the writer claims holds that "surface support is an inherent right of the purchaser," we can only say, that for purposes of his own, he quotes only part of the decision, and that part cites a premise that has been recognized by the large mining companies for many years.

The last published decision of the Supreme Court, on the question of surface support, was in the case of Stilley *vs.* the Pittsburg-Buffalo Coal Co., a bituminous coal mining company, rendered last year. It is known as Case No. 234 and will be found on page 492 of the Report of the Supreme Court of Pennsylvania, for the year 1912. The decision was by Judge Elkins.

Briefly stated, Judge Elkins decided that in the case of a man purchasing a lot, if the seller reserves the mineral right, and there is no specific written agreement, or no clause in the deed giving the owner the right to mine the coal without regard to surface support, the owner of the surface has an inherent right to proper and safe support. But, in the case of the purchaser of a lot, agreeing in writing to waive all rights to damages incident to mining, or in case the deed accepted by the purchaser contains a clause or paragraph in which the owner of the mineral reserves the right to extract the mineral without being liable for damage to the surface, the surface owner has no cause for action against the mining company.

There are three kinds of deeds in the anthracite regions. The oldest ones are ordinary deeds in which the mineral was not reserved. In such cases the surface owner owns everything beneath the surface of his lot. If a mining company trespasses on his underlying mineral, or by improper working of subjacent minerals injures his property, he can, on proving his case, get judgment against the company.

Next in point of age are the deeds in which the mineral right is reserved and there is no waiver of right to damages by the purchaser on account of mining. In this case, the owner of the surface has an inherent right to protection.

The more recent deeds, not only reserve the minerals for the original owner, but contain provisos that the owner of the surface waives all right to recovery for damages due to mining the mineral under his surface. In such cases the Supreme Court decided that the waiver clause frees the mining company from any liability due to surface damage, regardless of the number of transfers of the property.

The editorial in the *Coal Age* for some reason or other does not mention this part of the decision, but practically states that the same "inherent right" carried with the first and second classes of deeds, belongs to the third class also. In creating such a false impression it is mischievous, as well as abusive and misleading.

Put the Blame Where It Belongs

ON THE occasion of a volunteer firemen's convention in an eastern city, some years ago, nearly 4,000 firemen from various parts of the state were in attendance. The convention lasted a couple of days, and an incident of it was a firemen's parade. During two evenings and late into the nights, the comparatively small business sections of the city of 100,000 inhabitants, were the scenes of considerable "horse play," and in some instances, downright rowdyism, accompanied by drunkenness.

The writer, while in company with a friend, looking at the parade, commented on the fine appearance of the men in line. His friend said: "Yes, they make a fine appearance now, but their actions last night and the night before prove them to be a pretty tough crowd." The writer thought a moment, and then said: "Two hundred men, more or less drunk can raise considerable disturbance in a small city, especially when congregated on an aggregate of less than a mile of streets, can't they?" The friend replied: "Yes, they can." In response to the query: "Do you think there were 200 men engaged in the rowdyism last night and the night before?" he answered, "No, I hardly think there were that many."

Do you see the point, reader? He, like many others, was thoughtlessly blaming nearly 3,800 men who behaved themselves for the actions of less than 200. In other words, less than 5 per cent. of the crowd of

visiting firemen, through their actions, caused blame to rest on the 95 per cent. who conducted themselves in an orderly and respectable manner.

In case of labor troubles, in which incendiarism and violence have their part, the case is somewhat the same, especially with coal mine workers. Men who have been thrown in close contact with mine workers know that as a class they are law abiding. As in every other large body of men, there is a small percentage of reckless, vicious persons. They are the ones that, in time of labor disputes, cause trouble, and commit acts of violence or incendiarism that bring down on the whole body of strikers the condemnation of law-abiding citizens, and cause the adoption of repressive measures by the civil and military authorities.

In the state of Colorado there is an extensive strike of coal miners now in progress. Violence and incendiarism of an outrageous character have been a feature of it. Undeserved sympathy for those who commit criminal acts from the majority of the strikers, men who, under other circumstances, would denounce violence, has encouraged them in their criminal acts. Their examples and their incendiary speeches have drawn many others into deviltry, who without the antagonism engendered by the strike, would not commit an overt act, but would have simply exercised their legal right to refuse to work until the conditions demanded were obtained. As a result, there is practically civil war in southern Colorado. There can only be one end to it. Law and order will triumph. But, with the triumph, there will be a reckoning of the cost. Aside from monetary cost, there will be the cost of innocent lives sacrificed, and a serious blow to the labor organization under whose auspices the strike was called; for, the organization will be blamed by the non-mining public for the acts of its radically vicious members, just as the firemen were blamed for the actions of a comparative few.

The United Mine Workers, and for that matter, other labor organizations, will never wield the power they are capable of, till the officers and the large law-abiding percentage of members, not only cease to give aid and sympathy to the vicious lawbreakers, but also use their power as an organization to assist the civil authorities in maintaining peace. If this state of affairs is ever reached, labor disputes will be settled on their merits, the losses to workmen and employers will be minimized, there will be no occasion to call out the militia, and the labor organizations will have the moral support of thousands of citizens who now look on them with disfavor.

PERSONALS

J. F. Menzies, general superintendent of the Northwest Improvement Co., resigned his position, to take effect on December 1, to become manager of the Carbon Hill Coal Co.'s property, at Carbonado, Washington.

A recent bulletin from the West Virginia Department of Mines announces E. J. Flanagan and John Phillips as mine inspectors of the 8th and 11th districts, respectively. Karl Schoen, mine inspector of the 1st district has resigned, and will be succeeded by W. B. Riggleman, of Thomas, W. Va.

J. W. Shook, vice-president and general manager of the Central Iron and Steel Co., at Holt, Ala., has resigned his position with that company. W. L. Klutz, of the Republic Iron and Steel Co., has been appointed as his successor.

The Consolidation Coal Co., has selected Judge A. W. Young as its counsel in Kentucky. He has selected attorneys E. Hogge and James Clay to assist him.

The Chicago and Eastern Railroad has appointed Jabez Wooley, of Evansville, Ind., to manage its coal interests at Paxton, Ill.

A. B. Kelley, superintendent of the Dearth plant of the H. C. Frick Coke Co., has resigned to accept a similar position with the J. H. Hillman Co., at Hillsboro, Pa.

The South Fork Mining Co., has appointed M. J. Rafferty as superintendent of its operations, succeeding the late James Gallaghan, Sr.

Arthur R. Miller, superintendent of the Leisenring No. 3 plant of the H. C. Frick Coke Co., has tendered his resignation, to take charge of the coal, coke, and lumber operations of Francis M. Ritchey, Jr.

Walter R. Calverley, for the past 6 years general superintendent of the Berwind-White Coal Mining Co., with headquarters at Windber, Pa., resigned his position, effective November 1. After a vacation on the Pacific Coast, Mr. Calverley will outline his plans for the future.

George Watkin Evans, consulting coal mining engineer, of Seattle, has completed the examination of the Matanuska coal field of Alaska, for the United States Navy. Mr. Evans will soon resume his private practice in Seattle.

George B. Glenn, who recently resigned as general manager of the Sunnyside Coal Co., has been succeeded by Charles Ling, formerly connected with the Valley Smokeless Coal Co.

A. W. Evans, whose address was given in the October issue as Chattanooga, Tenn., is now located at Harriman, Tenn.

Governor Tener, of Pennsylvania, has appointed James E. Roderick, W. R. Calverley, and W. R. Crane, to cooperate with the United States Bureau of Mines in the establishment of a mine experiment station.

Elmer O. Long, assistant chief engineer of the Consolidation Coal Co., at Somerset, Pa., resigned to engage in business with Frank B. Fluck, consulting engineer at Somerset.

L. W. Trumbull has been appointed State Geologist of Wyoming, succeeding C. E. Jamison.

The Colliery Engineer

COAL MINING & PREPARATION

Short Mountain Breaker

A Breaker Especially Built by the Summit Branch Mining Co. to Minimize the Breakage of Soft Anthracite

By William Z. Price

THE Summit Branch Mining Co. has recently erected a breaker at its Short Mountain colliery, Lykens, Pa., which is unusually simple in its construction and efficient in operation.

Figs. 1 and 2 show the east and west sides of the breaker, respectively. The building, which is constructed on the mountainside, is 126 feet wide and 124 feet deep with the apex of the roof about 90 feet above the loading track, thus no part of the building is very high, removing any possibility of vibration, so wearing on the machinery.

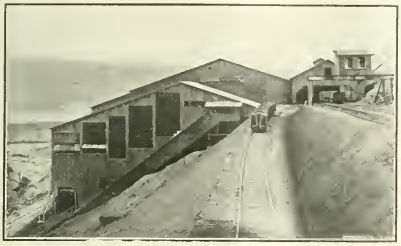


FIG. 1. EAST SIDE, SHORT MOUNTAIN BREAKER

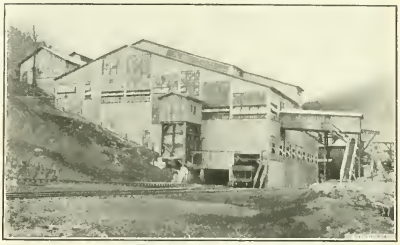


FIG. 2. WEST SIDE, SHORT MOUNTAIN BREAKER

In the breaker and adjoining engine house there is a total of 8,700 square feet of glass which adequately lights the structures. In cold weather the building is heated throughout by exhaust steam, heat being an important factor in the smooth running of the machinery. The breaker was constructed so as to add many features not found in old-style breakers, such as comfort, maximum lighting, safety from fire and machinery, and the prevention of degradation of coal, and therefore is the composite design of the experiments and ideas of various men.

The coal at this colliery is probably softer than any other anthracite, save that at Trevorton at the western end of the middle anthracite field, and at Bernice in the Loyalsock region, and must therefore be handled as gently as the extremely hard and brittle coal of the Hazleton field. With this in mind, arrangements were perfected to reduce degradation as much as possible.

The mine cars from the slopes or drifts are made into trips, on the surface and hauled by a steam locomotive to the breaker. The cars are covered with doors, as may be noted in Fig. 1; otherwise, owing to the extreme pitch on the slopes in places, the coal would certainly fall out of the cars.

The loaded cars at the head of the breaker are dumped by means of an end dump operated by steam and controlled by a three-way valve. The post and valve stem may be seen at the left of the dump in Fig. 5. It is possible, by means of this valve, to quickly raise and lower the car several times up to an angle of 55 degrees in order to discharge any wet coal sticking in the car. This method saves both time and labor, compared to the old one of barring out the coal clinging to the car bottoms. The dump was designed by the company engineers and constructed by the Mt. Carmel Iron Works.

The cars approach and leave the dump by gravity, but owing to occasional bad weather and to the fact that the wheels often "stick," etc., an overhead endless rope haul shown in Fig. 5, has been installed. This haul, which consists merely of a ¾-inch wire rope with attached hooks for cars and grips for the rope, saves the labor and time usually required to move cars whose "running gear" is out of order. The system is operated by a 25-horsepower General Electric motor situated at the eastern end of the haul, which is operated from the head of the breaker by the controller shown at the right of Fig. 5.

The coal which is discharged from the car into a hopper is gradually released through a gate into a Wilmot double-strand chain conveyer, whose

flights are 12 in. × 48 in., and whose trough is 82 feet long with a pitch of 5⅛ inches to the foot. This conveyer carries the run-of-mine coal to the dump or coarse-coal shaking screens *a*, Fig. 4, where it is separated into lump and steamboat, broken, and egg sizes; everything smaller passes through an egg coal screen and is treated on the counter screens as dirty coal.

All coal which passes over the 4½-inch openings of the upper screen is lump and steamboat, and as there is little or no demand for such sizes, it passes over a picking table *b*, from which the rock is picked by hand, while the coal is carried to one of the two pairs of rolls *c*. If broken coal is desired, No. 1 rolls are put in use; if egg coal, No. 2 rolls are used.

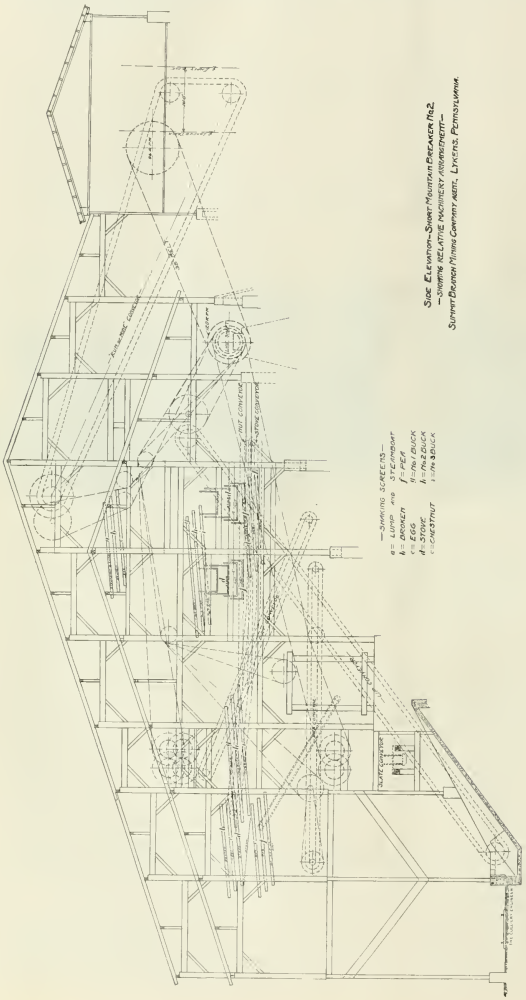

SIDE ELEVATION—SHORT MOUNTAIN BREAKER No.2.
—SHOWING RELATIVE MACHINERY ARRANGEMENT—
SUNNY BROOK MINING COMPANY AGTS. LYKENS, PENNSYLVANIA
—SHAKING SCREENS—
a = LUMP AND STEAMBOAT
b = BROKEN
c = EGG
d = CHESTNUT
f = PEA
g = NO. 1 BUCK
h = NO. 2 BUCK
i = NO. 3 BUCK

Fig. 3. Side Elevation, Short Mountain Breaker

To break brittle hard coal down from lump to egg is bad practice, the rule being to break lump to broken size, and broken to egg. In this case, however, two crushings would undoubtedly create more small sizes than the one to which the coal is subjected.

From the rolls the coal passes to the roller shaking screens *d*, which prepare three sizes for market. The top screen has 3¼-inch openings and all passing over this goes to the broken coal pocket *e*; all that passes through the top screen, and over the middle screen, which has 2¼-inch openings, is egg coal, and is sent to the egg coal pocket *f*. The third screen of the nest *d* has a 1½-inch mesh, and all coal passing over that is stove coal, and sent to the stove coal pocket *g*; all the coal which passes through this screen goes to the screens *h*.

Returning to the coarse screens *a*, the coal passing over the second or broken screen, goes into a chute *i*, where it is hand picked. In case there is a demand for broken coal, it leaves the chute and goes to a retarding conveyer *j*, which delivers it to the broken coal pocket *e*. In case there is no demand for broken size, the coal passes from the chute *i* to the No. 2 rolls at *c*, and after crushing, goes to the roller shaking screens *d* and to the respective pockets.

The egg coal from the coarse screens *a* is picked free from rock, and lowered by a retarding conveyer *k* to the egg coal pocket *f*.

Having disposed of the coarse coal, the preparation of that coal which passes through the stove screen of nest *d* and on to the top screen of nest *h* is to be considered. The holes in the top screen are ⅞

inch in diameter, and the coal that passes over it goes to the chestnut (nut) coal pocket *l*. The second screen has a ⅝-inch mesh and all coal passing over it is termed pea coal and goes to the conveyer *m* which delivers to the pea coal conveyer *n* and so on to the pea coal pocket *o*.

The coal passing through the pea coal screen is sized into Nos. 1, 2, and 3 buckwheat and sent to the slant conveyer *p* and thence to lip screen shakers *q*. Anything smaller than buckwheat No. 3 is sent to the dirt pocket *r* and sold for making briquets. The small coal riddled from the lip screens when loading railroad cars is slushed to the slant conveyer *p*, which carries it to the screens *q* where it is sized. If there is any stove coal, which is not likely, unless a car is condemned, it goes to conveyer *s* and to the stove coal jigs *t*; the nut coal to conveyer *u* and nut coal jigs *v*; and the pea coal to conveyer *n*, which delivers it to the pea coal pocket *o*.

The buckwheat coal goes from shakers *q* to conveyer *w*, and thence to buckwheat shakers *x*, which are in four nests. These screens deliver to the No. 1, 2, and 3 buckwheat pockets *A*, *B*, and *C*. The buckwheat shakers *r* are worked wet, as shown in Fig. 6, and whatever passes through them as a discard goes to the slush bank.

So far, the flow sheet has dealt with what is generally termed pure coal, it having been hand picked before it reached the rolls, and it now remains to follow the course of the coal which passed through the coarse or dump screens *a* and went to the counter screens *D*, and *E*. From screens *a* there are two carrying screens with ⅜-inch mesh which allows the buckwheat to go to ³²⁄₃₂-inch mesh shaking screens *D* and carries the remainder to the screens *E*. The first pair of screens *D*, sizes buckwheat 1, 2, and 3; the second pair *E* gives stove, nut, and pea, that passing the pea screen going to the buckwheat conveyer *w*. The stove and nut coal go to their respective jigs *t* and *v*, and thence to the pockets, except that stove size, when not carrying too much slate, is diverted to a hand-picking table to avoid breakage in the jigs.

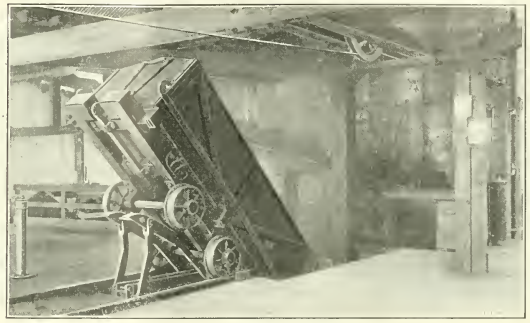


Fig. 5. Dumping Apparatus

The dirt from the carrying screens and the screens *D*, goes to the dirt conveyer *F* and is delivered to the dirt pocket.

The rock which was picked from the picking table below the dump screens, is sent by a chute to the rock pocket *G*, if clean rock, and to the rolls *H* if coal clings to it. After passing the rolls the material goes to the slant conveyer *p*, and so on to the shaking screens *q*, etc.

It will be noted that no elevators are used in this latest model of anthracite breakers, almost innumerable tests at other collieries having proved that conveyers represent considerable saving in handling the coal. Everywhere in the breaker the soft anthracite is handled as carefully and gently as possible. Curves instead of angles are seen in all the chutes. The retarding conveyers have 8″ × 22″ wooden flights set at 3-foot intervals, in sheet-iron troughs. Their pitch is about 35

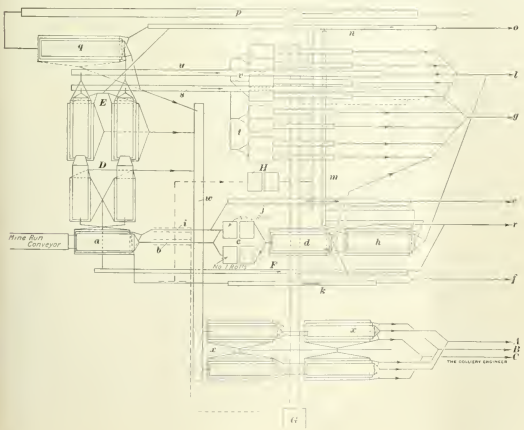


Fig. 4. Flow Sheet, Short Mountain Breaker

degrees and speed of the flights varies from 20 to 40 feet per minute.

The shaking screens have a speed of 150 strokes per minute with a 6-inch throw. The jigs have a speed of 108 strokes per minute.

The pitch of the chutes, conveyer lines and shakers, the design and spacing of the roll teeth, in fact, every feature and integral part of the operation, is the result of experiments conducted in the old breaker during the past year.

The pockets are constructed of steel which was first heavily coated with a black non-corrosive mineral paint before the planking was laid, then a continuous layer of roofing material was placed over it and then the hardwood lining. Owing to railroad cars varying in height, the coal is not allowed to drop indiscriminately into the cars after being so carefully handled in the breaker, but telescopic loading chutes, shown in Fig. 7, are used, which are adjustable to any height and, of course, minimize breakage.

The power for driving the machinery comes from an 18″ × 30″ Vulcan duplex engine which drives the line shafting by means of a 38-inch belt. The line shaft pedestals are set in concrete piers and the shaft which extends the width of the building drives the various shaking screens, rolls, jigs, etc., by means of ropes and belts. Ropes predominate, however, as only five belts other than the driving belt are attached to the line shafting, whereas 21 ropes lead away to various parts of the building. This method of setting the line shafting takes it off the timbers of the structure, where it is always subject to change of alinement and consequent trouble.

There is a significant and important feature in the construction of the breaker, and that is the storing of the rock. The excess weight added to any breaker by a rock pocket causes great strains on that part of the structure. In this breaker this has been eliminated by making the rock pocket entirely separate from the breaker proper, but yet adjoining it on the west side of the building, as shown in Fig. 2. The rock is removed by hoisting cars from the rock bin 500 feet up the mountainside and then running them to the rock dump. The same plane is used to hoist cars containing boiler coal, from the buckwheat pockets located on that side of the building, up to the level of the head of the breaker, whence a steam locomotive takes them to the boiler house.

As much hand picking of the coal as possible is done, and there are no mechanical separators, except the jigs, in use. Thus it is seen that the breaker has been designed not so much as a labor saver as to prevent the degradation of coal, and the results more than justify the expense incurred in the building of the breaker. The average daily production at present is about 1,500 tons, although the breaker has a capacity of 2,000 tons.

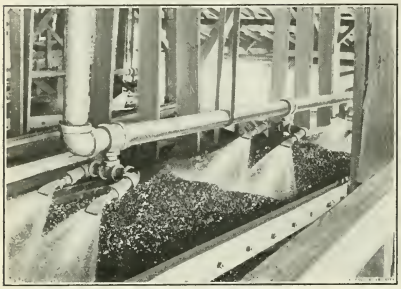


Fig. 6. Buckwheat Shakers

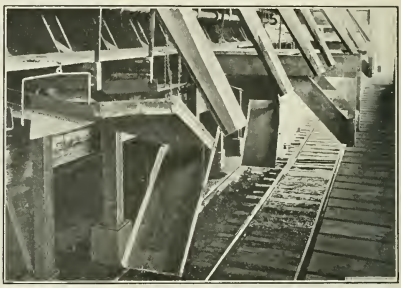


Fig. 7. Loading Track and Chutes, Looking East

Williams Valley Mining Institute

The first banquet of the newly organized Williams Valley Institute was held in Williamstown November 1, and attended by over 300 men from Lykens and Williamstown. After an excellent dinner, addresses were delivered by President Morris Williams, of the Susquehanna Coal Co., and Robert A. Quin, general manager of the company. Both are very much interested in the new organization, and in their speeches pointed out the advantages and opportunities that such an institute held out to the mining men in Williams Valley.

The institute has under way plans for the immediate opening of night mining classes, which will be held either in Lykens or Williamstown, as may be decided at an early date.

The highest point in Nevada is Wheeler Peak, which, according to a chart published by the United States Geological Survey, is 13,058 feet above sea level. The average elevation of the state of Nevada is 5,500 feet. Only four states, Utah, Colorado, Wyoming, and New Mexico, are higher.

The Origin of Coal

The Principal Important Factors—Changes Traceable from Living Vegetation to Anthracite or Graphitic Minerals

By Wilbur Greeley Burroughs

COAL is derived from vegetable matter by a series of changes which are plainly traceable. Starting with living vegetation, there is an unbroken chain of substances, vegetation, peat, lignite, bituminous coal, anthracite, and some graphitic minerals, each of which grade into one another, thus reaching from complex organic living matter, and then oxidized compounds, at one end of the series, to nearly, but not quite, pure carbon at the other. Since all of these bodies, except the graphitic minerals, are indefinite mixtures, which vary in composition, it is impracticable to write chemical equations that shall properly represent their transformation, even though the outward changes taking place can be readily followed, and the series made complete.

In a detailed consideration of the genesis of coal, the factors of most importance are the following: growth and accumulation of the organic matter, and the kind of organisms contributing directly, or indirectly, to the accumulation of coal forming material, with the relative proportions of each.

Conditions and duration of the initial process of organic decomposition.

Nature and energy of the dynamic forces bringing about subsequent alteration of organic residues.

There has been considerable controversy in the past as to whether the coal was formed from vegetation transported to where the coal beds now are, or whether the vegetation remained *in situ* in the place where it grew.

The most reasonable and widely accepted theory, is that the vegetable matter grew and accumulated in the places where it is now found changed into coal; the clays which in the great majority of cases underlie the Carboniferous coals, being without doubt the old soils in which the vegetation of that time thrived luxuriantly.

Although some investigators still maintain that the vegetable matter was transported to its final resting place, the evidence that the great majority of coals were formed where found is the following: (R. 2)

(*a*) The purity of many coal beds that extend over great areas; for had the vegetal matter been washed to where the coal now is, from higher surrounding lands, it would have been mixed with earthy sediment, and the resulting coal would necessarily have been impure.

(*b*) Many of the coal beds over great areas, sometimes many thousand square miles, are of nearly uniform thickness. This would hardly be the case, if the vegetable materials had been accumulated by being drifted together; but, by the formation of coal from vegetation *in situ* hypothesis, a uniformity of thickness in the coal beds, due to the uniform growth of plant life, is exactly what one would expect.

(*c*) Beneath each coal bed, a bed of clay generally occurs. This clay is often filled with roots in the position of growth. The clay, therefore, represents the soil in which the vegetation originally grew.

(*d*) Fossil stumps of trees, standing in the position in which they grew, have been found above coal beds.

(*e*) The numerous imprints in the rocks above and below coal beds, or in associated shales, of delicate ferns, and of fragile plants, indicate that they were buried where they fell, and were not transported by moving water, for plants in transport are twisted, rumpled, torn, and disintegrated, so that they will seldom remain in recognizable condition.

(*f*) A layer of rock, overlying a coal bed, often contains abundant remains of vegetation, especially in its lower part, where trunks of trees from 50 to 60 feet long, and from 2 to 3 feet in diameter, have been found. It would appear from this, that the sediment which went to make up the rock layer, was brought in, and deposited first amongst, and then on top of, the vegetation, burying the organic life which later was to be changed into coal.

(*g*) The vegetable matter of the coal beds is made up of the trunks, small stems, leaves, and fruits of various plants, intermingled in such manner, as to make it certain that the vegetation grew where the coal now is, for in vegetation drifted together, while the trunks, small stems, leaves, and fruits, would not be completely separated, one from another, still they would not have been left so commingled as these various plant remains are.

Although most of the workable coal was formed from vegetation *in situ*, it is true that in some cases, coal has been formed from vegetation drifted together. This is the case in some of the small coal basins of France, where vegetable matter washed down from the land, was changed into coal (R. 1).

Having now seen that in the great majority of cases, coal was formed from vegetation in place, the next thing to consider is under what conditions the vegetation grew and accumulated.

In the Upper Carboniferous (Pennsylvanian) period, there were peneplains, or surfaces which had been brought nearly, but not quite, to base level, covered by luxuriant vegetation, where now are the Appalachian and Interior Carboniferous coal fields. Here, growing under the favoring influence of a humid, and extraordinarily (R. 1), equable, though not necessarily a tropical or even subtropical climate, the plants grew in the greatest profusion, often attaining large size. As these areas were peneplains, and hence near to base level, their drainage must have been poor, and

swamp conditions have existed. Some of these Carboniferous swamps were along sea shores, and some in shallow basins, or undrained areas remote from the sea, for marine fossils are found in association with some coal beds, and fresh-

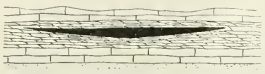


Fig. 1

water shells in association with others. Some of the patchy coals of North America, such for example, as the Sharon coal of western Pennsylvania and northern Ohio (R. 1), indicate deposition of vegetal matter in quiet pools, behind bars or reefs, or in estuaries, deltas, etc.

Some coal beds, such as the Pittsburg bed, are continuous over great areas; while many coal beds cover but a small area, the swamps they formed being of small extent. The margins of swamps, or shallow seas, constitute the original limits of each coal bed (Fig. 1). In some instances the swamps covered only a few acres, but of such depth that 20 feet and more of coal was formed. Such deposits (R. 9), owe their limited area to the unevenness of the coal measure floor (Fig. 2). The rock formations upon which the vegetable matter accumulated, had been eroded, and ravines, valleys, and all the topographic features common to an eroded land surface of the present day, had been formed. In these ravines, and other similar depressions, the swamps would be of small area; and the resulting coal beds, also, of necessity would be small. The floor upon which the coal vegetation grew might, also, be uneven, due to unequal subsidence (R. 10), or elevation; or, to gentle folds or undulations. Small ridges sometimes occurred in the swamp, taking the place of the vegetation, so that locally, the coal seam is very much thinner, and often entirely pinched out over the elevations (Fig. 3). Occasional currents brought in sediment during the accumulation of the vegetal matter, so that the bed was divided into two or more parts. This sediment, later became carbonaceous shale, often called "slate" and bone. When this "slate" bed in the coal is narrow, it is called a "parting."

Conditions somewhat similar to those of the Carboniferous (Pennsylvanian) period, can be found at the present time in the costal plain areas of southern Florida, in marshes along some parts of the Atlantic coast of the United States, and in the Dismal Swamp of Virginia, and North Carolina. The various cypress swamps, and the multitude of marshes and peat bogs of the United States and Canada, furnish further examples of the growth and accumulation of coal forming material. In some of these swamps where the surrounding land is too low to allow an inwash of sediment, or where the swamp itself, is too large to permit the sediment that is washed in, to contaminate to any

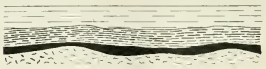


Fig. 2

degree the accumulating vegetable matter, we find coal forming vegetation accumulating uncontaminated to any extent by sand or mud, and the great Carboniferous coal beds often are free from impurities.

The growth and accumulation of vegetation was often stopped by subsidence of the coal forming areas, or rise of land underlying near-by bodies of water, which caused the water to flow in over the swamps, drowning the plants, and burying the marshes under the mud, sand, or shells, which the invading waters brought with them. That this took place, is shown by the fact that in the Appalachian trough the coals are generally capped by clays, or sands, usually mingled, and often containing large plant fragments, though in rare instances, a limestone lies directly on the coal. Proof of subsidence is so clear in the coals of the larger fields, or marine basins, that (R. 1) presence of large coal areas in any region is, in itself, evidence of extensive submergence of base-leveled land.

Often one or more coal beds occur one above another, separated by shale, sandstone, or limestone. In Nova Scotia there are said to be 80 coal beds, though not all workable. The second coal bed in the section shows that swamp conditions must have again occurred in the region, similar to those conditions existing before the burial of the first coal bed (R. 2). The second swamp would owe its existence (*a*), either to a re-elevation of the region proper, sufficient to cause the waters to withdraw; or a withdrawal of the waters due to some more remote earth movement, the waters becoming shallow enough to allow of the growth of swamp vegetation. This new vegetable accumulation would subsequently be buried by another submergence of the region (*b*). Or, through sedimentation the sea or lake bottom where the first bog had been, was built up to such a level that the sea or lake became shallow enough to allow the growth of a swamp vegetation, and thus the formation of another swamp would be possible.

Further submergence of the region would result in the drowning and burying of the second swamp. By the first hypothesis there must be an oscillation of level; the second hypothesis calls for only a general sinking of the region, the only elevation being due to aggrading sedimentary deposition, and not to re-elevation of the region proper, as in hypothesis (*a*). Neither hypothesis can be applied to all cases, for as T. C. Chamberlin points out, local unconformities abound in the coal measures, showing that the surface

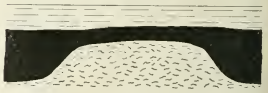


Fig. 3

was locally out of water and subject to erosion at various times and places in the course of the Pennsylvanian period; and that changes occurred in the relative level of land and water, though whether the land or the water, or both, were the

changeable elements, cannot be ascertained.

Coal beds sometimes divide, the two parts diverging from one another; or traced in the opposite direction, two coal beds will sometimes unite. This bifurcation of coal beds may be brought about as follows: In Fig. 4*A* (R. 2), a peat bog forms along *f-d*. The interior of the swamp sinks as in *B*, so that sediment, brought down from the land, is deposited over a part of the bog. The depressed area becomes aggraded as at *C*, sufficiently for another peat bog to form. This second peat bog finally is transformed into coal. Thus, two beds of coal, *e f*, and *e g*, separated by a deposit of sand or mud changed to sandstone or shale, when continued to the right, unite and form only one bed of coal; for on the right the accumulation of vegetable matter, *e d*, has not been interrupted from the time of formation of the first bog.

In Fig. 5, is shown a more complicated series of events. This bifurcation of coal beds has been explained by A. Winslow, (R. 9) as follows: "At *B*, is a coal bed, originally horizontal, which extended entirely across a submerged area before subsidence set in again: at *C* is another bed which extended, however, only a short distance before being submerged; at *A* is a third coal bed which had a longer period of growth than *C*, but which was

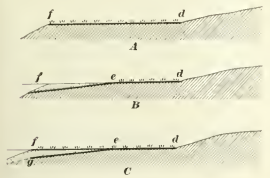


Fig. 4

also cut off by a sinking of the strata. From the divergence of lines *A* and *B* it is evident that the rate of subsidence was greater over the interior than at the margin. Before the formation of the bed *D*, the margin *A*, was elevated and the depression in the interior continued, and these opposite movements were kept up during the periods of accumulation of the strata *E* and *F*, and of those intervening between these.

The organisms contributing directly, or indirectly, to the accumulation of coal forming material were doubtless many kinds of trees, ferns, grasses, sedges, mosses, etc. Sometimes a number of plants contributed to the vegetable accumulation without a predominance of any form, in other cases the accumulations resulted from the growth of a single species of plant (R. 4). At present in Europe, moss predominates in the peat bogs. In America, the bogs are due to the growth of a number of aquatic plants, especially some varieties of water lilies. In Asia, wild rice is the chief peat forming plant. With the coal forming vegetal matter, some animal remains were undoubtedly commingled, helping to increase the percentage of nitrogen in the coal. The ash from the organic matter forming the coal was added to, more or less, by inorganic sediment, derived from the wash of the land in times of flood.

Ordinary lignites and so-called bituminous coals are derived (R. 1) predominantly, from the tissues of vascular plants, fragments of which are still nearly always plainly in evidence.

Boghead coal, a pure algal coal, is composed largely of remains of certain gelatinous seaweeds or algae (R. 1). The algal coals are microscopically distinguished by their conchoidal fracture; have a rather dull black surface, a greasy or waxy abrasion when scratched by some hard instrument, a more or less distinctly brownish tint when broken in thin edges; often a golden yellow color in thin sections; and usually are massive and unlaminated. H. Ries states that it is often difficult to say what proportion of some coals is woody matter, and what is algal matter but it is regarded by some, that algal matter may be the dominant factor in forming the properties of coal.

The Paleozoic cannel and splint coals are characterized by great numbers of spores (R. 1), and pollen grains, and a relative scarcity of woody matter, such as natural charcoal, or "mother of coal." Cannel coal is high in nitrogen, and Newberry long ago, pointed out that fish remains are abundant in cannel coal (R. 3), from which he argues that

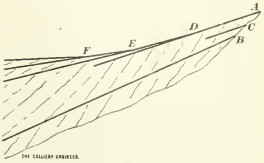


Fig. 5

the beds of cannel coal were formed under water, and that vegetable matter formed a carbonaceous paste, in which the fish remains became embedded and which consolidated to produce cannel coal. Analyses of fossil plants show very little nitrogen, while cannel coals are abnormally high in that element; the obvious explanation for the high percentage of nitrogen in the cannels is that the element is largely due to fish remains, as already set forth by Newberry.

The following analyses of fossil plants and of cannel coals show that fossil plants contain very little nitrogen, while the cannels are abnormally high in nitrogen (R. 3).

	A	B	C
C.....	82.45	83.58	87.89
H.....	4.75	5.77	6.53
N.....	.43	2.21	2.08
O.....	12.37	8.44	3.50

A = average of 6 analyses of fossil plants, from the coal beds of Commentry, France. The plants were perfectly preserved as to structure, but were entirely transformed into coal.
B = analysis of Wigan cannel.
C = analysis of Tyneside cannel.
All of the above analyses are recalculated to the ash-free basis.

Regarding the origin of natural charcoal or "mother of coal," David White (R. 1), writes as follows: "Most paleo botanists and chemists still treat the fragments of carbonized wood, or natural charcoal, the so called "mother of coal," which forms layers in so many of our bituminous coals, as the remains of cinders; the work of forest fires, which

have either been washed into the accumulating mass of vegetation in the peat bog or swamp, or partially burned on its surface." White, who disagrees with this theory, goes on to say: "The phenomena of vegetable decay and accumulation as witnessed notably in peat bogs at the present day, appear to justify the belief that these fragments of wood, or bark, often rounded and water worn, owe their form and condition more or less directly either to a partial dry rot of the woody matter under subaerial conditions before immersion, or as seems more probable, to temporary exposure of the coal forming accumulation to the air, the results being largely the same. The great amount of the charcoal, often in repeated layers, the large size of some of the fragments, the mutual relations of the fragments in the same layer, and the action of the fundamental jelly on the fragments, appear to invalidate the cinder hypothesis.

Furthermore, it is not difficult, in the abundant charcoal layers which form so large a part of the coals of southern and western Illinois, and along the western margin of the Appalachian coal field in eastern Kentucky, to find large numbers of single pinnae and feather leaved forms of pinnules of even the more delicate types of ferns or Pecopteris lying in the midst of the pieces of charcoal in layers more or less completely infiltrated or perhaps hardly cemented by the fundamental ground mass. These delicate fern impressions are similarly converted to natural charcoal, even the nerves (villi) of the pinnules being charred and in all respects like the associated fragments of wood. It is not probable that these pinnules so frequently were drifted and buried in their perfection among the coarse piles of wood after having first been charred by forest fires on the land; or that they mark fire-swept bogs from which the ash layers were removed. On the contrary, it may be more reasonable to conclude that the peculiar preservation is due to water, etc.

REFERENCES

R. Reference.

1. "Some Problems of the Formation of Coal," by David White, in Economic Geology, Vol. III, pages 292-318.

2. Chamberlin and Salisbury, Geology, Earth History, Vol. II.

3. U. S. G. S. Bulletin 330.

4. "The Maximum Rate of Deposition of Coal," by G. H. Ashley, in Economic Geology, Vol. II, January-February number.

5. "A Practical Classification for Low-Grade Coals," by M. R. Campbell, in Economic Geology, Vol. III, pages 134-142.

6. "Hypothesis to Account for the Transformation of Vegetable Matter into the Different Grades of Coal," by M. R. Campbell, in Economic Geology, Vol. I, pages 26-33.

7. Economic Geology, by H. Ries.

8. U. S. G. S. Bulletin 316.

9. Missouri Geological Survey, Preliminary Report on Coal, page 30.

10. Iowa Geological Survey, Vol. 2, pages 178-180.

New Coal Field Investigated

Among the many areas of coal land examined recently by the United States Geological Survey, in connection with its land-classification work, is the Little Sheep Mountain field, Mont., described by G. S. Rogers in Bulletin 531-F, just published by the Survey. The area is about 60 miles from Terry and contains about 1,440 square miles. The Little Sheep Mountain field, in common with all the others in this vicinity, was examined with a view to the classification of the land and the valuation of that part underlain by coal or lignite. The coals of this area seem to be on the boundary line between lignite and subbituminous coal.

Under present economic conditions it is held that no bed of this grade of coal thinner than 30 inches is workable, although in the examination of this field all beds down to 24 inches were mapped, and many thinner ones were examined. From the data thus gathered, only beds 30 inches or more in thickness being taken into account, the total quantity of coal in the Fort Union coals of the Little Sheep Mountain field is estimated to be 2,218,340,080 tons; if all beds of a thickness greater than 14 inches are counted the total is 2,560,790,560 tons.

The bulletin may be obtained from the United States Geological Survey, Washington, D. C.

Coal Mining Institute of America.

The winter meeting of the Coal Mining Institute of America will be held at the Fort Pitt Hotel, Pittsburg, December 4 and 5. The program as announced is as follows:

December 4, 10:30 A. M., business session.

1:30 P. M., address, "Efficiency of Bituminous Coal Mining," Harrington Emerson, consulting engineer, The Emerson Co., New York City. Question box. Paper, "Safeguarding the Use of Electricity in Mines," Clyde G. Brehm, electrician, The Oliver Snyder Steel Co., Uniontown, Pa. Address, Jesse J. Johnston, Pittsburg, Pa.

6:30 P. M., institute banquet, Fort Pitt Hotel, announced speakers, Dr. W. J. Holland, H. M. Wilson.

December 5, 10 A. M., paper, G. A. Burrell, engineer United States Bureau of Mines, "The Relative Effect on Men and Small Animals of Small Amounts of Carbon Monoxide." Paper, "Basic Coke," J. R. Campbell, chief chemist, H. C. Frick Coke Co., Everson, Pa. Paper, "What is a Proper Method of Sampling the Beehive Coke Ovens for Analysis," F. C. Keighley, general manager Oliver Snyder Steel Co., Coal Department, Uniontown.

1:30 P. M., paper, "Stray Electrical Currents," Mr. Ellwood, consulting chemist, Greensburg, Pa. Picture show, illustrating coal mining fields and transportation problems in Alaska, Dr. W. R. Crane, Dean Mining Department, Pennsylvania State College. Address, "Portable Electric Lamps for Use in Mines," H. H. Clarke, electrical engineer, United States Bureau of Mines.

Madison Coal Corporation Exhibition

A Visit to No. 8 Mine at Dewmaine, and No. 9 at Cambria—Demonstration by Fire-Fighting and First-Aid Organizations

Written for The Colliery Engineer

INVITATIONS were sent by A. J. Moorshead, President of the Madison Coal Corporation, to various mine operators, mine inspectors, and others interested in coal mining in Illinois to visit his mines and witness the first-aid, fire-fighting, and rescue exhibition of his employes. About 40 individuals accepted the invitation, and for the comfort and convenience of those who arrived the night before, board and sleeping accommodations were prepared at Carbondale. The demonstrations were given on October 14, at the corporation's No. 8 mine, at Dewmaine, and No. 9 mine at Cambria. These mines are a short distance above Carterville and 2 or 3 miles west of Herrin, Ill.

Fig. 1. Group of Mining Men at Madison Coal Corporation Exhibition

The Madison Coal Corporation is closely connected with the management of the Illinois Central Railroad; and under the direction of A. J. Moorshead, president and general manager, a most efficient organization has been developed that is marked by the latest ideas in coal mining practice. The properties of the company, which are in the central and southern coal fields of Illinois, are divided into three divisions. The northern, with mines at Divernon and Mt. Olive, is under the superintendency of George A. Simpson; the middle division, of two mines with headquarters at Glen Carbon, is under the superintendency of Anton Denzer. At Glen Carbon is also the office of the chief mining engineer, G. E. Lyman. The southern division is under A. W. Miller, and includes the No. 8 mine, at Cambria, and the No. 9 mine at Dewmaine, at which the demonstration herewith described took place.

Fig. 2. Run-Around at Shaft Bottom

By reference to The Colliery Engineer for June, 1913, page 627, it will be seen that Mr. Moorshead believes in organization as a means for accomplishing results, and the arrangements for this demonstration showed that he had a most efficient organization. The official organization of the Madison Coal Corporation is shown in the chart.

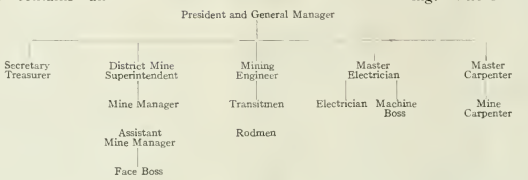
To reach Cambria a special train was taken from Carbondale, and the No. 9 mine visited. When the Madison Coal Corporation acquired its No. 8 and No. 9 mines, they had been in operation a number of years and were not modernly equipped mines by any means. Since they have belonged to the Corporation, however, the plants have undergone a gradual alteration and reconstruction on the surface, while underground they have been modernized and brought up to date. Unfortunately, our correspondent's photograph of the No. 9 surface plant is not suitable for making a cut, but it

shows an old-style wooden tipple back of which is a modern, brick power house, and in the foreground a handsome brick rescue station. To the left of the rescue station there is a carpenter shop equipped with woodworking machinery for car construction and the general miscellaneous woodwork needed about such plants. Between the carpenter shop and the power house is a brick machine shop, equipped with planers, drill press, and lathes for pipe threading and other purposes. The armatures and some of the other parts of the electrical machinery are repaired in this shop, a corner of which is shown in Fig. 10.

The power house contains an 18″ × 36″ duplex hoisting engine, a direct-connected 200-kilowatt generator, and four pumps. In the boiler room of the power house there are four 200-horsepower boilers, with provisions made for the installation of additional boilers when needed. The fan house, shown in Fig. 4, as well as the other buildings, tipple excluded, are in line so that the plant presents a businesslike appearance. The fan house, which is typical of the new buildings that are replacing the old, contains a 5-foot wide by 14-foot diameter steel-cased Jeffrey fan, whose shaft is connected at each end with a 19″ × 20″ engine. Both of these fan engines are kept running so that they may be in condition, but in case of an accident to one, the other has sufficient power to operate the fan. The fan is reversible, and large explosion doors are provided over the head of the shaft, but are not shown in the cut, although the top of the escapement stairway is. This fan, under test, furnished 290,000 cubic feet of air per minute with 6-inch water gauge. The fan also is equipped with a self-recording pressure gauge and is an excellent example of modern ventilating machinery.

Organization Chart, Madison Coal Corporation

A. J. Moorshead



One of the novel features at the shaft surface landing shown in Fig. 3, is the safety door standing upright in the background that can be dropped over the shaft compartments in case of fire in the tipple or at any time that it is desired to protect the shaft from falling timbers or other material. When the mouth of the shaft is closed by the safety doors, air is taken from or admitted to the shaft through a tunnel leading to one side just below the landing. The steel safety gates shown in the foreground can be opened only by the engineer from his platform, and he can open them only when the cage is at the landing and not while it is moving, unless he leaves the platform and disengages the automatic locking device. Any effort to open the gate from the landing sounds a gong in the engine house. This gate and an arrangement for signaling the engineers from the cage at any point in the shaft are the inventions of A. J. Gurney, the master electrician of the Madison Coal Corporation.

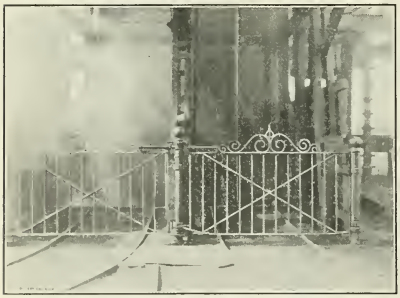


Fig. 3. Gurney Automatic Shaft Gate—Smoke from Explosion Coming From Shaft

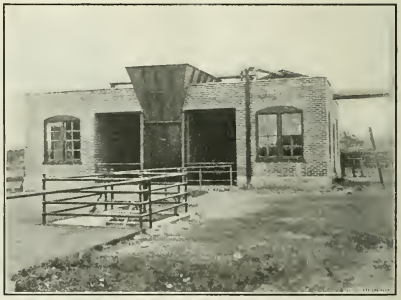


Fig. 4. Fan at No. 7 Mine

The rescue station is a substantial brick building with a steel trussed roof. At each of the mines of the Madison Coal Corporation there is a similar rescue station and the equipment of each at the present time consists of three Fleuss rescue outfits, Fleuss electric lamps, a Fleuss oxygen pump, 6 stretchers, and Red-Cross first-aid boxes.

Fig. 5. Rescue Cars

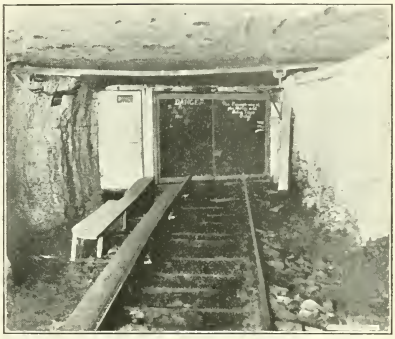


Fig. 6. Automatic Door

Preparatory to going into the mine, the guests were furnished with jumpers, overalls, caps, and carbide lamps, but everything was so clean and orderly about the bottom that the change of clothes was almost superfluous. When the party disbanded in the afternoon, Mr. Moorshead told every one to take with him his mining suit, as a souvenir of the day.

After the party had descended the shaft, a signal was given for a fire drill by the shaft bottom force. The shaft is thoroughly equipped with all of the appliances required by the state law, to fight fire, and immediately upon the sound of the signal, each man took an appointed place and very soon several lines of hose were ready for use. Men with hand extinguishers also took appointed places, and, as on the surface, a man with spare hose and nozzle went from place to place to see if his services were needed. One foreman was sent to the east of the shaft to guide the men from that side of the mine to the shaft, one went to the west for a similar purpose, and one took up his station at the equipment shaft, so as to prevent crowding at that point. These men spoke encouragingly to the outgoing men, assuring them that there was ample time for escape, and thus keeping them in order and preventing a panic.

The party then inspected the shaft bottom and were much impressed by the way matters were arranged. As shown in Fig. 2, the company was obliged to build large concrete walls and use steel cross-bars or arched concrete roof, as the old workings had cut the shaft pillar badly.

The underground hospital, manager's room, pump room, and stables, were visited, and in all of this inspection a miner's lamp was not needed, as the walls were whitewashed and the passageways well lighted by electricity. At the No. 9 mine there are six rescue outfits; three for a team of white men, and three for a team of colored men. These, with an equipment for a team of three men, kept at the No. 8 mine, provide nine oxygen helmets available for almost immediate use at either the No. 8 or No. 9 mine; the two mines are only 1½ miles apart. The company expects to increase the equipment of rescue apparatus until there are five sets for each station, thus making a rescue corps of five instead of three, as at present. Regular drills are maintained in the use of rescue apparatus and in rendering first aid to the injured, and already the company has a most efficient rescue squad at each mine, which is being constantly increased by new recruits and made more efficient by constant practice. In each station is also kept a file of current mining magazines and the training room is thus also made a general reading room for the men about the mine.

After the surface plant had been thoroughly inspected, the fire signal was given and a fire drill was held, the supposition being that the tower was on fire; the shaft fire doors were lowered, water was turned on in the tower, and water from two lines of hose was turned on the building, one on the north and one on the south side. At the same time men with hand fire extinguishers swarmed over the tipple and within a minute and a half after the time the signal blew, water was being poured on from a number of points. One man with the spare hose and nozzle went from place to place to see if hose or other supplies were needed. So quickly was the water gotten on the building that it seems very unlikely that a serious fire could occur about the plant. Fig. 9 shows the colored first-aid and rescue team of the Madison Coal Corporation, which gave an excellent exhibition at the Illinois

field day of the Mine Rescue Commission, during State Fair week.

Afterward an alarm was given that an explosion had occurred in the mine, simulated by burning powder in the shaft, to show smoke coming from the shaft, as in Fig. 3. The helmet men on the surface immediately went to the rescue station, donned their apparatus, and tested it in the smoke room before going to the shaft. This feature of the training and in connection with the preparation for an accident should be especially commended, for no rescue apparatus now available is perfect, and failure on the part of the apparatus may mean the death of the wearer, therefore, ample time should be taken to test all of the appliances before a rescue party enters the mine.

A corps of five men equipped with Fleuss apparatus, electric lamps, canary birds, and first-aid supplies entered the mine with instructions to proceed to the seventh southwest entry, as information had been received that the explosion was at that point, and that there were two men there, one overcome by afterdamp, and one otherwise injured; this information having been sent to the surface from an inside telephone station. When the helmet men reached the bottom, they took the rescue cars shown in Fig. 5, and proceeded to the scene of the supposed accident. The rescue train consisted of two mine cars reconstructed for the purpose, by having a seat along each side, the under part of the seat being a box in which was stored tools and the first-aid supplies likely to be needed at the scene of an accident, also hand fire extinguishers. In each car there were also four springs, one in each corner of the car, to which a stretcher can be attached, and so form an ambulance car. The third car of the rescue train contained a 50-gallon fire extinguisher. About half an hour after the rescue squad had descended the shaft, word was brought back by one of them that it was safe to descend, and the entire party accompanied by eight first-aid men went down the shaft. By this time the helmet squad had brought the men from the scene of the accident to the shaft bottom, where first aid was rendered them with the pulmotor, and suitable bandaging was applied. This work was especially commended by John C. Duncan, superintendent of the Benton Illinois Mine Rescue Station. Treatment of this kind would be given ordinarily in the mine hospital near the shaft bottom, but owing to the number of sightseers it was not possible for them to get inside the hospital at one time. After being given first-aid treatment, the two injured men were taken to the top, placed in the company's ambulance, shown in Fig. 11, and carried to the company's hospital at Dewmaine, there to await the arrival and inspection of the visitors. This hospital is equipped with four beds; contains an excellent operating room and one of best X-ray machines in Middle West. It is under direction of Doctor Springs and Mrs. Springs, who, in addition to being a trained nurse, is also a graduate in medicine. Before ascending, the visitors saw a demonstration of a flying switch at the shaft bottom. An automatic switch is placed so that a locomotive can cross from one track to another, and in doing so, set the switch so that a trip will continue on the straight track.

On reaching the surface the photograph, shown in Fig. 1, was taken at the head of No. 9 shaft, and then, after a most strenuous morning, as outlined, the next function was a

Fig. 7. Fire Alarm

Fig. 8. Fire Practice, Mine No. 8, 1¼ Minutes After Alarm

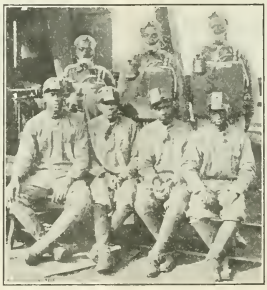


Fig. 9. Colored First Aid and Rescue Team

delicious lunch served in the power house by the ladies of the town. After luncheon the party entrained and proceeded to No. 8 mine, at Dewmaine, where a surface fire drill was given, illustrations of which are shown in Figs. 7 and 8. This drill was most efficient and was similar in general to the one witnessed at No. 9 mine, but while No. 9 mine was not working, the No. 8 mine was in operation and the drill was, therefore, performed under routine conditions.

The party went below and inspected the concrete and I-beam construction about the shaft bottom. The Madison Coal Corporation has been compelled to use an unusual amount of concrete construction, owing to the shaft pillar being badly broken by the previous operators. The party also visited the automatic doors that are used in this mine. In Fig. 6 is shown a pair of doors, and to one side a small door through which men in traveling pass, they being unable to work the automatic doors.

After coming to the surface, a demonstration of first aid was given by two corps of men and at the conclusion of this very creditable performance, several of the party thanked Mr. Moorshead and the Madison Coal Corporation for the courtesies that had been extended to them and commented favorably upon the excellent equipment of the efficient organization manifested by all of the proceedings of the day. Mr. Moorshead replied in his usual happy vein.

At the conclusion of Mr. Moorshead's address the party walked to Dewmaine and inspected the office and the club room over it, also the hospital and the general surface arrangements, which includes a bakery, butcher shop, and an excellent general store; also separate schools that the company maintains for white and colored children. About 500 men are employed at the No. 9 mine, which has a daily output of 3,000 tons, while No. 8 mine has a daily output of 2,500 tons and employs 400 men.

In Fig. 12 is shown the plan, end, side elevation, and details of the roof of the Madison Coal Corporation's rescue station at Glen Carbon, Ill. The walls are of brick and the roof is of reenforced concrete carried on steel trusses. The building, therefore, is fireproof, and while no pretensions are made to anything elaborate, the designs show accommodations for the rescue apparatus and equipment together with the provision of means for practice with the helmets, such as an individual mine could reasonably be expected to maintain.

The first-aid room is intended for such treatment as may be deemed necessary on the surface before the patient is removed to the hospital. It is also used for lecture work and first-aid practice by the men. The room is equipped with a table and chairs, and the leading trade and technical journals are kept on file, the idea being to make it an attractive place for the rescue men to congregate.

The two large closets in the rear of the building are the places for storing the first-aid material, as well as the helmets and their accessories.

On the right side are two shower baths, both containing two modern showers with hot and cold water, and a dressing room of the same size is also provided. There is a door between these two rooms. On the left is a smoke chamber 8 ft. × 16 ft. in size, fitted with overcast tunnel and lift weights, where practice may be had in a gaseous atmosphere. One of these stations is provided for each mine operated by the Madison Coal Corporation.

Owing to the kindness of Mr. Moorshead and to G. E. Lyman, mining engineer, we are able to furnish the following bill of materials for this building:

24 cubic yards 1-inch crusher-run lime rock.

24 cubic yards, clean river sand.

30 barrels Portland cement.

18 thousand brick.

20 barrels lime.

6 window frames for 12″ × 14″ × 4L. × 1⅜ plank; two for 9-inch and four for 13-inch wall.

5 pairs sash, 12 in. × 14 in. × 8L. × 1⅜ in.

Fig. 10. Machine Shop, No. 9 Mine

Fig. 11. Ambulance, Doctors, and Hospital

2 window frames for 12″ × 14″ × 8L. × 1⅜″ plank; two for 9-inch wall.

2 door jambs for 2′ 8″ × 6′ 8″ × 1⅜″ for 9-inch brick partition wall.

2 doors, 2 ft. 6 in. × 6 ft. 10 in. × 1⅜ in. with horizontal panels.

Chicago, but all voting the day a success in every way and of special value in showing what has been done by a progressive mine management in Illinois in a very short time to build up an efficient first-aid and mine-rescue organization. The rescue, fire fighters, and special rules of

far as possible, all injuries caused by thoughtlessness, carelessness, indifference to danger, or by violation of mining laws and rules and regulations governing the operations of mines.

A. J. Moorshead,
President and General Manager.

Fire Rules

1. All fire equipment shall be tested in actual drill "not less than once every 14 days," both on the surface as well as in the mine workings.

2. The alarm of fire, on the surface, shall be short, continuous blasts of the steam whistle.

3. The ringing of the electrical alarm gongs indicates fire in the underground workings:

(a) Continuous unbroken ringing of the

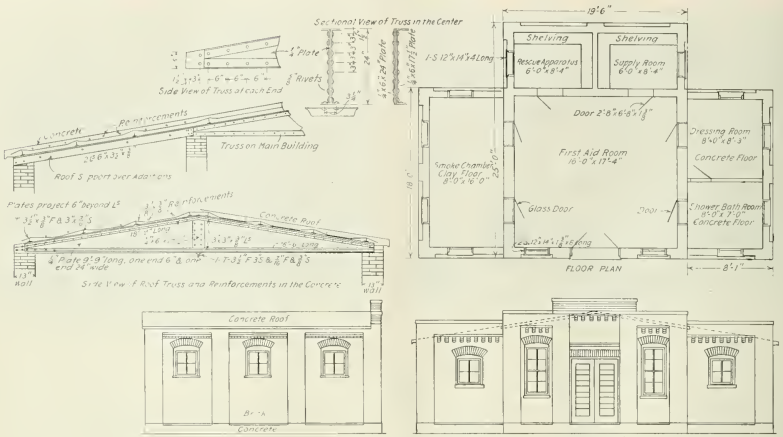


Fig. 12. Plans and Details of Rescue Station, Madison Coal Corporation

1 outside frame for two 2′ 6″ × 6′ 10″ × 1⅜″ doors, square tops.

7 pieces structural steel, **T** shape, 3½″ × ⅜″ F and 3″ × 7/16″ stem.

8 pieces structural steel, **L** shape, 3″ × 3″ × ⅜″, 18′ 6″ long.

8 pieces structural steel, **L** shape, 3″ × 3″ × ⅜″, 18′ 9″ long.

12 ¼-inch sheet-steel plates, 9 feet, 9 inches on the side, 24 inches wide at one end and 6 inches at the other.

200 ⅝″ × 2¼″ button-head rivets.

400 ⅝″ × 2″ button-head rivets.

44 pieces ⅜″ × ⅜″ corrugated or twist bars, 11 feet long.

15 pieces ⅜″ × ⅜″ corrugated or twist bars, 12 feet long.

15 pieces ⅜″ × ⅜″ corrugated or twist bars, 14 feet long.

About 4:30 P. M. the special train left for Carbondale, and at 6 P. M., the party disbanded, some going to St. Louis and adjoining towns; others waiting for later trains to the Madison Coal Corporation are appended:

Special Rules for the Government of the Employes of the Madison Coal Corporation

First. Always carefully examine the mine examiner's record book, and all employes whose places are shown to be dangerous must go to the mine manager or the mine manager's assistant for instructions before entering the mine.

Second. Motormen, trip riders, and drivers are the only employes allowed to ride on the motors and pit cars, as their special duties require them to do, and all others are prohibited and hereby warned not to ride on motors or pit cars.

Third. When entering the last cross-cut or any working place beyond the last open cross-cut, care must be exercised to see whether it is marked "safe" or "dangerous" and not enter or attempt to work in any place where the mine examiner's danger mark is shown, unless under the instructions or in the company of the mine manager or one of the mine manager's assistants.

Fourth. Machine runners and helpers, as well as loaders, must sound the roof, face, and rib of their respective working places before commencing work each day, and must make all dangerous places safe by removing loose coal and putting up such timbers as may be found necessary. A great many of the most serious accidents are caused by taking the chance of finishing the loading of a car before putting up timbers and making a "drummy" roof secure and safe and promptly removing loose coal from the face and ribs; and all employes engaged in such duties are hereby warned against the continuance of such dangerous practices.

Fifth. All wires in mines should be considered dangerous and must only be handled by those whose duty requires them to do so.

Sixth. The object of these instructions is to impress every employe with the necessity of exercising caution in order that accidents may be reduced to the minimum and to prevent, as gongs means all employes go to the main shaft.

(b) A succession of short rings of the gongs means all employes go to the escapement shaft.

4. Upon hearing the fire alarm gongs, it will be the duty of the mine manager and his assistants to go to their respective stations at the bottom of each shaft, as directed by the district superintendent, to give directions and preserve order.

5. After the fire alarm has been given either on the surface or below ground, no coal except that on the ascending cage must be hoisted, and both cages must be immediately relieved of cars.

6. All men upon hearing the alarm of fire must immediately go to their respective stations and prepare the pumps, hydrants, hose, and chemical extinguishers for action. Drivers, motormen, trip riders and others must immediately give notice to all employes in their respective districts and exert their best efforts to aid in the safe escape of the entire force.

7. Hoisting engineers must remain in the engine room and obey regular signals and the orders of the district superintendent or mine manager.

8. The firemen must remain at the boilers unless otherwise directed by the district superintendent or mine manager.

9. The head dumper or weigh boss, as may be directed, shall have charge of the gates and guard the shaft at the surface landing, and attend mine signals.

10. The head bottom cager will retain charge of the cages and attend to fire alarm and other signals at the shaft bottom.

11. The machinist's duty will be to stand by and attend to the fire pumps only.

12. It shall be the duty of the head blacksmith or his helpers (as may be designated) to open valves for conveying water to the fan house and all water pipes on the surface and in the mines.

13. Certain assigned duties shall be given to a sufficient number of men to take charge of valves connected with all underground fire pipe lines, handle the hose on the surface and in the workings, and take charge of the chemical extinguishers, both in the surface buildings as well as in the mine.

14. Under no circumstances must hay or straw be permitted to be loaded into a car and sent into the mine until all miners of the day shift are on the surface, and must then only be lowered into the mine after it has been inspected by the hoisting engineer or top foreman to see that the hay and straw are in bales and contained in a closed forage box with lid securely fastened to make it impossible of ignition from any cause, and the hoisting engineer on duty at the time is charged with the knowledge of such inspection.

15. The first duty of the night watchman or such other person as shall be designated by the district superintendent or mine manager (when the weather permits) shall be to unreel two lines of hose (one on each side of the mine) and open the hydrant valves.

16. On the discovery of fire at night, the steam whistle must be blown and the electric alarm gongs sounded as indicated in Rules 2 and 3.

17. The night force must, upon the alarm of fire, go to their regular stations and duties assigned to them by the district superintendent or the mine manager.

The greatest degree of protection and safety to life and property can only be secured by cool, active action on the part of those in charge of the supervision of the forces and those in charge of the fire apparatus, as well as calmness and good order on the part of all employes leaving the mine.

Fire apparatus must not be handled by any one except those authorized to do so, and then only in case of fire or for the purpose of drill and repairing. Any person known to mutilate or damage any part of the fire machinery and appliances will be prosecuted, and in addition thereto will, if an employe, be discharged.

A. J. MOORSHEAD,
President and General Manager.

RESCUE RULES

1. It will be the duty of the mine manager to know that the breathing apparatus in all its parts is complete and properly cared for, and by actual test, not less than once every 14 days, in the gas room of the mine-rescue building, determine whether the rescue apparatus is in safe and effective condition.

2. It will also be the duty of the mine manager to know that the mine-rescue building is kept in a clean and orderly condition, that all safety lamps are properly cared for and ready for immediate use, and that all supplies required in connection with rescue work are kept in ample quantities.

3. In case of fire, whether the result of an explosion or not, stop the fan only long enough to determine the quantity of air and proper direction to force the ventilation to provide for the safety of those who may be in the mine.

4. Upon hearing the alarm of fire or the warning of explosion, the regularly organized rescue parties will immediately go to their respective places and make preparations to enter the mine under the direction of the district superintendent and mine manager, who will be governed by the rescue rules prepared by the manager of the Illinois Mine Rescue Stations.

5. When the danger signals are given because of fire or otherwise, the foreman of the first-aid corps must immediately telephone to the company's physician and other doctors if necessary, and see to it that his force is ready to care for the injured.

6. Immunity from accidents in general can only be secured by all employes thoughtfully performing their duties as required by the mining laws of the state and the company's rules for the government of its mines. It is furthermore necessary that there be complete co-operation between the employes and the management in maintaining an efficient fire fighting and rescue organization, coupled with a well trained first-aid corps.

The knowledge that complete efficiency in this respect exists should bring immeasurable satisfaction to the mine workers and their families and in the most complete way possible compensate all employes for their full and active support in making this feature of the service a complete success.

A. J. MOORSHEAD,
President and General Manager.

More than 3,000 small logging operators now buy national forest timber; at least 25,000 persons, settlers, miners, stockmen, and others, obtain timber from Uncle Sam's big wood lot for their own use free of charge.

The Cost of Coal Mining

The Margin Between the Cost of Producing and the Selling Price Shown to be Remarkably Close

*By Edward W. Parker**

IN ORDER to do justice to the subject and to the occasion, a paper on the cost of coal mining prepared for presentation before the American Congress should be based upon an extensive study of the records, not too many, of typical operations in a sufficient number of states to get results capable of analytical comparison and deduction. Unfortunately, when I was asked by the Secretary of the Congress to prepare this paper there was not time to collect data from which such a study could be made, and I have been compelled to adopt as the basis of this discussion the latest official statistics available, those of the Thirteenth Census of the United States, which covers the calendar year 1909. Since that time wages have been advanced in both the anthracite and bituminous districts, and prices of the product have been raised to compensate for (and in some cases, possibly more than offset) the increased cost of production.

If at the outset I may be permitted to make a suggestion as to one thing needed in the coal mining industry (looking at it from the standpoint of the statistician and economist) it is a standardization in the methods of accounting. It is difficult—one might say impossible—to compile accurate statistical data regarding cost and value of product when operators themselves cannot tell what their product costs nor what they actually receive for it, and when their only means of judging whether they are making or losing money is by their bank accounts. Within the present year the Geological Survey was requested by one corporation, whose value of production is measured by tens of millions, to furnish statements of its output some ten or fifteen years ago, which it was unable to ascertain from its own records. The only reason that the Survey could not comply with the request was that the schedules and tabulations are kept for 2 years only, for purposes of comparison, and are then destroyed, as there is no place where they can be safely stored and the best method of maintaining their confidential character is to burn them.

In the anthracite region particularly is it difficult to secure accurate information, not only in regard to mining cost, but also the value at first hand of the output. A large proportion of the anthracite is sold at so much a ton delivered at Buffalo, or Chicago, or Milwaukee, or wherever it may be, and the sale price of the coal at the mines includes the freight to the point of delivery and is so entered on the books. Until a recent action of the United States Supreme Court abolishing the contracts between the anthracite companies and the transportation interests, all the anthracite shipped to New York harbor ports for a number of years has been sold on a percentage basis of the tidewater price, the railroads taking 35 per cent. for the freight and returning 65 per cent. to the operators. The magnitude of the task of determining what the actual value of the product is, was rather forcibly brought home to me last spring, when I called at the New York office of one of the big anthracite companies for the purpose of urging the expediting of that company's report. It had furnished complete reports of production, by sizes, for its numerous mines, but had omitted any statement of values. I had written a letter urgently requesting as accurate a statement of the value as I had received of the production, and had been promised the additional information. The auditor brought for my observation sheet upon sheet of

*United States Geological Survey.

closely written figures, upon which the calculations necessary to get the data had been made. It had taken the entire time of one clerk more than 2 weeks to do the work.

What goes into mining cost is in many cases as difficult to ascertain. As many here well know, the old wooden or corrugated iron breakers in the anthracite region of Pennsylvania are giving way rapidly to modern structures of reinforced concrete or other fireproof construction. I have been reliably informed that the investment in most of these cases is charged, not to capital account, but to mining expenses. It must, of course, eventually go into the cost of mining, but it seems to me that it is an investment, not an expense, and when charged into the cost of mining should be in the form of depreciation, and of interest on the investment. These are cited merely as examples of the complexities which confront the economist when he undertakes to analyze such statistics as he finds available. There is a somewhat general impression that the mining of coal, both anthracite and bituminous, is a highly lucrative avocation, and that the principal occupation of the so-called coal barons is to look pleasant as the golden stream flows into their coffers. I venture to state, taking the industry as a whole, that there are few lines of industrial endeavor where, during the last 10 years, there have been smaller returns for the capital invested and for the energy, mental and manual, that has been put into it, than in the business of coal mining. As has already been observed, the only recent official statistics of relative cost and value available are those presented in a recent bulletin published by the Bureau of the Census and which cover the calendar year 1909. This report shows that the value of the Pennsylvania anthracite produced in that year was $148,957,894. The total gross expenses amounted to $139,110,444, from which should be deducted $4,864,844 made up from charges to miners for explosives, oil, and blacksmithing, making the net expenses $134,245,600. The total gross expenses are itemized as follows:

Services:		
Salaries	$ 4,572,489	
Wages	92,169,906	$ 96,742,395
Supplies:		
Fuel and power	3,189,279	
Other supplies	23,472,809	26,662,088
Royalties		7,969,785
Miscellaneous		7,736,176
Total gross expenses		$139,110,444
Deductions		4,864,844
Net expenses		$134,245,600

The total production in 1909 amounted to 72,215,273 long tons, so that the average value per ton for the output in that year was $2.06; the average cost per ton was $1.86; and the net returns on the operations for the year were $14,712,294, or an average of 20 cents per ton. This at first glance looks like a fair return, but attention must be called to the fact that the census figures of cost make no allowance for interest on capital invested or borrowed, and no offsetting charges for amortization or depreciation. According to the returns to the Bureau of the Census, the entire capital invested in anthracite mining in 1909 was $246,700,000, which may appear rather inadequate when one considers the magnitude of the industry, and an annual production of $150,000,000 (in 1911 the output was valued at $175,189,392 and in 1912 it was $177,622,626), but I am taking the figures reported by the Census Bureau. If on this capitalization an allowance of 4 per cent. be made for interest, the net returns for the year amounted in round numbers to $4,844,000. If, as I suggested at the outset, new breakers and other equipment are charged into operating expenses, no allowance need be made for depreciation, but surely the exhaustion of from 75,000,000 to 80,000,000 tons from the reserves every year should have some amortization charged against it, and if 5 cents a ton be allowed the margin of $4,800,000 is practically wiped out. At least it may be said that from the operators' standpoint there may have been some reason for the recent advances in the price of anthracite, the effect of which the author of this paper has felt as keenly as any other consumer of anthracite.

The figures covering the cost and value of bituminous coal show even more striking comparisons. I may remark here that there are some slight differences in the statistics of production between the census figures and those published by the United States Geological Survey, for the reason that the census investigations excluded mines producing less than 1,000 tons, whereas the Survey rakes the country with a fine-tooth comb and includes every small "country" bank, from which it can secure a report. For 1909 the Survey showed a bituminous coal production of 379,744,257 short tons valued at $405,486,777, and the Census Bureau showed a production of 376,865,510 tons valued at $401,577,477, the difference being about 3,000,000 tons in quantity and $4,000,000 in value—less than 1 per cent. in either case. As the census figures for cost of mining are the basis of this discussion, the census figures of production are also used.

The total value of the bituminous production, as already stated, was $401,577,477, and the mining expense of producing this value, including salaries of officers, was $378,159,282. As in the case of anthracite, the expenses of production do not include any charges for depreciation, amortization, or interest on capital invested or borrowed. The expenses are divided as follows:

Salaries	$ 20,417,392
Wages	282,378,886
Supplies	45,345,932
Royalties	12,035,900
Miscellaneous	17,961,172
Total	$378,159,282

From this it appears that 75 per cent. of the total cost and 70 per cent. of the total value was spent in wages. Salaried officials got less than 5.5 per cent.

Now, let us see what capital got. The total capital invested in the bituminous coal mines of the United States in 1909 was, according to the Census bulletin, in round numbers $960,000,000 ($960,289,465), and I do not think that this looks as if there were very much over-valuation, whatever the capitalization may be

as represented by stock issue. The difference between the value of the product and the expense of producing it was $23,440,000 (I shall talk the rest of this in round numbers), or a fraction over 2.5 per cent. on the capital. The average value per ton of all the bituminous coal produced in the United States was $1.07, the costs averaged a fraction of a cent over $1, so that the margin of profit to cover interest, depreciation, and amortization was a little less than 7 cents a ton. In some states the expenses exceeded the returns. Take Arkansas, for instance, where the expenses totaled $3,630,526 and the value of the product was $3,508,590. Other instances were:

	Value of Product	Expenses
Iowa	$12,682,106	$12,816,076
Kentucky	9,940,485	10,127,987
Tennessee	6,548,515	6,691,482
Oklahoma	6,185,078	6,536,441
Virginia	4,336,185	4,392,440

Pennsylvania, by long odds the most important producer, with an output of 137,300,000 tons, showed a total of expenses of $117,440,000 and of value of $129,550,000, a balance on the profit side of a little over $12,000,000, or about 3⅓ per cent. on the capital invested, $358,600,000. The four competitive states, West Virginia, Illinois, Ohio, and Indiana, which rank second, third, fourth and fifth, respectively, in producing importance, all show such narrow margins between income and outlay that profits are visible only with a microscope. The figures follow:

	Value of Product	Expenses	Difference
W. Va.	$ 44,344,067	$ 43,024,716	$1,319,351
Illinois	53,030,545	51,697,504	1,333,041
Ohio	27,353,663	27,153,497	200,166
Indiana	15,018,123	14,906,831	111,292
	$139,746,398	$136,782,548	$2,963,850

These four states with an aggregate production of a little more than the bituminous output of Pennsylvania, showed a total of less than $3,000,000 as the excess of receipts over expenses. The capital invested in the coal mining industry in these states was something over $310,000,000, so that the returns on the capital were less than 1 per cent.

I do not wish to tax the patience of this audience to the breaking point, but there is one other fact to which I desire to call attention, and that is to the conditions in the public land states, which are also coal producers. They are California, Colorado, Idaho, Montana, New Mexico, North Dakota, Utah, Washington, and Wyoming. All of them showed favorable comparisons with other states. They produced in round numbers 25,000,000 short tons of coal in 1909. The value of the product was $37,000,000; the expenses, $32,400,000, the difference being, say, $4,600,000. The capital reported was approximately $70,000,000, so that the average earnings on the capital invested in these states* was between 6 and 7 per cent., as compared with less than 1 per cent. in West Virginia, Illinois, Ohio and Indiana, and of about 2.5 per cent. for all the bituminous coal mined in the United States in 1909.

I am not present as an advocate of the coal miners of the United States, nor have I prepared this paper in their interest. I must, in fact, confess that when I began, less than three weeks ago, a study of the Census bulletin, I was somewhat surprised at the facts presented therein, though I was somewhat familiar with the general situation. If there is any other branch of the mining industry conducted on such narrow, not to say dangerous margins, I should be glad, yet sorry, to know it, and when these figures are considered one must feel that if there is any mulcting of the people in the coal that goes into their heating furnaces and kitchen ranges, the coal-mine operators are not the robber barons. And when the dividing line between profit and loss is so faint, all the more credit is due to the men in authority who are throughout all of the coal mining regions spending thousands of dollars to reduce the hazard and improve the conditions under which the men work for the coal we burn.

*These figures include a small production, about 200,000 tons, valued at $300,000, from Georgia, with the expenses and capital incident thereto. All of the states mentioned except Colorado, North Dakota, and Wyoming, were grouped by the Census Bureau as "Other States."

West Virginia Coal Mining Institute

Prof. E. N. Zern, Secretary of the West Virginia Coal Mining Institute, announces that the winter meeting of this institute will be held at Charleston, W. Va., on December 8, 9, and 10.

The first day of the meeting will be devoted to a business session and a question-box session. Preceding this, however, will be an address of welcome by Governor Hatfield, responses by several of the vice-presidents and a presidential address by Neil Robinson.

The rest of the sessions will be devoted to the reading and discussions of papers and enjoying a very attractive program provided by a committee of Charleston mining men. In addition to a number of instructive papers on a variety of timely mining topics, two papers of especial importance to West Virginia mining men will be presented. One of these, by Hon. Lee Ott, Chairman of the Public Service Commission, will explain the new Workman's Compensation Law, which recently went into effect and which it is hoped will do much toward solving the problem of what we are to do for the families of the industrially killed and wounded. The other paper, by Dr. T. C. Johnson, of Charleston, will treat of the effect on the mine labor supply which the new prohibition amendment will have, and which goes into effect on July 1, 1914. The discussion on these two laws, which are of vital importance to the West Virginia mining industry, will bring out many points of interest.

The highest determined point in Florida is Mount Pleasant, 301 feet above sea level, according to the United States Geological Survey. The approximate average elevation of the state is 100 feet above the sea.

German Rescue Organization

The Development and Management of the Mine Life Saving Organization in the District of the Miners Association at Clausthal, Section 3, in the Year 1912

*By Bergassessor Breyhan, Duderstadt**

IN THE District of Section 3, Clausthal, without urging on the part of the mining authorities, the mine rescue organization was inaugurated as in other districts.

The corporation mines had, partly on their own accord, and partly through urging by the Board of Mines, looked into the acquisition of rescue apparatuses, and had established and drilled a rescue corps. However, the officials entrusted with the management and drill were inefficient, because they were not familiar enough with the working of the rescue apparatus and their effects, and because they lacked the theoretical knowledge to enable them to figure out beforehand the conditions for successful rescue work in case of need. Finally they almost entirely ceased to acquire new apparatus, and when they did, they had no confidence in its successful use, consequently, in most cases, no tests were made to prove that the rescue apparatus was in good working order before it was used.

While Section 3 of the Miners' Association had, as early as 1910, taken into consideration the regulating of the rescue organization in their district, i. e., of how the corporation mines could be made to interest themselves in the acquisition of modern devices, as well as in systematic development and drill of the rescue corps which furthered the efforts of the section in this line.

In the first place, a general order to the mine police in the district by the Board of Mines, at Clausthal, issued April 7, 1911, decreed in section 177 that in every independent mine at least two rescue apparatuses had to be installed, which would make it possible for the operators to work, notwithstanding the presence of gases, and that the manager of an independent mine would have to be responsible, not only for the proper care of the apparatus, but also for the continuous presence of an efficiently drilled rescue corps.

In conformity with the importance which the government authorities attributed to rescue organizations, and in view of the fact that the School of Mines was authorized

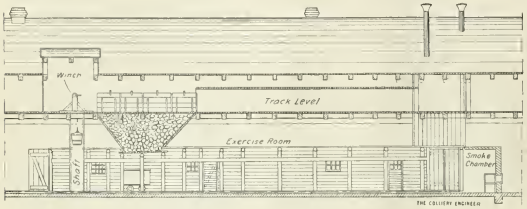


FIG. 1. ELEVATION OF RESCUE STATION

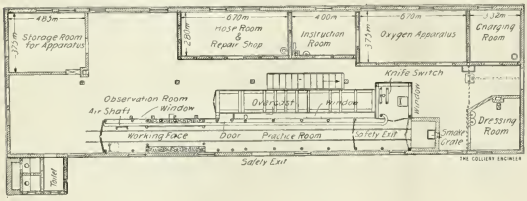


FIG. 2. GROUND FLOOR PLAN OF RESCUE STATION

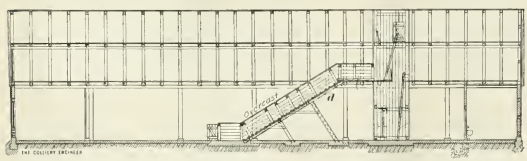


FIG. 3. SECTION THROUGH PRACTICE ROOM

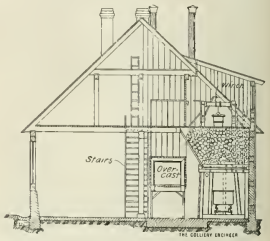


FIG. 4. SECTION THROUGH HOISTING SHAFT

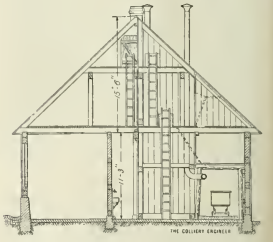


FIG. 5. SECTION THROUGH LADDER SHAFT

*Translated from *Glückauf*, September 20, 1913, by Karl Kopp.

to issue testimonials certifying to the technical and practical efficiency of foremen of the rescue corps (Acts of October 26, 1910, and December 4, 1911), general instruction and practical demonstrations in rescue work were included in the curriculum and made compulsory in all Prussian schools of mines, and no student could receive a diploma unless he had already properly passed his examination in this newly established branch.

Since it became a necessity for the School of Mines, at Clausthal, to add this new life-saving course to its curriculum, it was a matter of course that both the section and the school should unite in their efforts, especially since the united mines were thus enabled, by the students whom they sent to the school, to secure suitable foremen and instructors for their rescue corps.

The negotiations which had been taken up by the directors of Section 3 and the Board of Trustees of the school resulted in the section placing at the disposal of the school a certain sum for the establishment of a central station for the theoretical and practical instruction of rescue work in coal mines. In return, the school placed their instructors in rescue work at the disposal of the section, in order to regulate and supervise the life-saving organizations in the united mines.

As the Clausthal School of Mines had no suitable rooms for the storing of rescue apparatus and no quarters for instruction purposes, etc., and the erection of a new building for this special branch was found to be too expensive, a contract was entered into with the Director of the Royal Mine Inspection, at Clausthal, for the rent of an appropriate building. The latter designated the so-called "Burgstadter Magazingebaude," located between the two now idle shafts of the Anna-Eleonore and the Herzog-Wilhelm mines, not far from the Kaiser Wilhelm mine, as quite suitable for the purpose. This building, shown in elevation and plan, Figs. 1 and 2, had a ground and a garret floor which furnished about 10,535 square feet floor space. On the ground floor there is a dressing room, on the other side a storeroom for the oxygen apparatus of the Royal Mine Inspection at Clausthal. The rooms for practical drill and instruction work which extend from the ground to garret floor had to be newly constructed; there are in addition, four rooms on the ground floor, which are shown in the plan.

Of these latter the charging room occupies 3,708 square feet of floor space, and contains a Draeger high-pressure oxygen pump, driven by electricity, for ordinary operations, and a small Draeger emergency oxygen pump, driven by hand. There is also stored a contrivance for charging electric accumulator lamps together with the necessary testing devices, designed by Mine Foreman Franke.

Next to the charging room and connected with it through a large sliding window, is the storeroom for the oxygen apparatus, which is placed in especially constructed closets. There are apparatuses from Westphalia, Gelsenkirchen, models 1908 and 1912; from the Draeger Works, Lubeck, models 1904-1909 and 1910-1911, also one half-hour apparatus of the same firm. For instruction work there is also an aerolite for liquid air from the Hanseatic Machine Construction Co., at Hamburg. In addition, there are two resuscitation appliances, one Draeger Pulmotor and one Inhabad apparatus. Also, there is in the storeroom one Draeger stretcher with fresh-air helmet and one Westfalia with face mask for the introduction of oxygen. Those supplies necessary for practice, like oxygen flasks, potash cartridges, testing devices, etc., are close at hand.

Next to this storeroom and connected through a door, is the instruction room with a floor space of 388 square feet. Here is placed the recording clock for the work measuring machine in the practice pit. There is also an air testing device

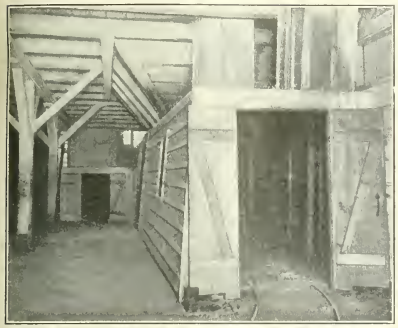


Fig. 6. Ground Floor of Practice House

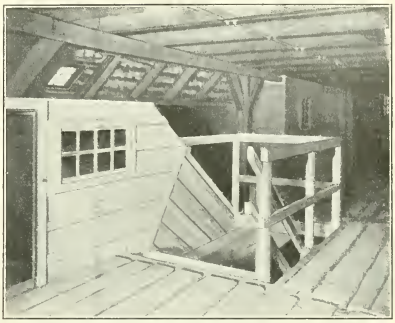


Fig. 7. Part of Garret

that provides for the examination of two gases.

Further, there is a hose room in which are placed, besides the necessary attachments, substitute parts for all apparatuses. It serves at the same time as a work shop, where minor damages can be repaired. The following parts have been provided: A complete pressure hose apparatus for helmet breathing from C. B. Konig, Altona (Elbe); a similar apparatus "Simplex" from the Hanseatic Machine Construction Co., Hamburg, for respiration by mouth; another from the "Westfalia" machine works, Galsenkirchen, for mask and helmet breathing. The latter is the property of the Royal Mine Inspection, Clausthal, and has been turned over to the central station for practice and instruction work.

In the garret there is a room containing all the miners' tools necessary for practical work.

All the rooms are lighted by electricity, the central station of the Kaiser Wilhelm mine furnishing the power.

The rooms necessary for testing the rescue apparatus extend over the ground and garret floors, as shown in the drawings. They consist of a single-track timbered gangway, 65.6 feet long by 5 ft×6 ft. cross-section. One end connects with the smoke chamber, constructed of reenforced concrete; the other end is provided with doors as shown in Fig. 6 and leads to the hall of the practice house. At the free end of the gangway a place for doing timber work has been provided. This consists in placing four sets of timber in a place above which there is a room with a capacity of 53 cubic feet. The material above the gangway is allowed to fill the gangway and through this the men drive. The level is cleared by loading out the gangway and hoisting the material by a windlass up a small shaft and returning it to the receiving room above the gangway for the next practice. In order that the operators should stand in the smoke, notwithstanding the encumbered level, the place where the work is done is connected by a conduit with the smoke chamber.

From the gangway a perpendicular ladder shaft, 7.5 qm. high, leads to the roof, as shown in Figs. 1, 3, and 5. From the ground floor there is an incline *d*, which connects at the garret floor with the climbing shaft by means of a low passageway, the transverse section of which is trapeziform and leads to the windlass chamber.

In the ordinary exercises the smoke is conducted from the smoke development chamber through the gangway, the smoke takes the same windlass shaft, spreading over the latter as well as the low passageway and escaping from the upper part of the perpendicular shaft through a short pipe in the roof. When driving through the material on the gangway, the smoke takes the same route, except that it passes from the smoke chamber through an air conduit.

By the aid of different doors the current may be regulated in such a way that it rises from the gangway into the shaft, or it may be introduced from the smoke chamber direct into the perpendicular shaft.

The different practice rooms have windows in appropriate places in order that the operators may be watched while working in the smoke-laden atmosphere. There are also safety doors and a flue that is in immediate connection with the chamber. Through the entire structure there is an electric wiring system, by means of which one may signal to any point. It is also possible to electrically illuminate the entire building by pressing one push button, an arrangement which is appropriate, especially if the operator should have a fainting fit, etc. In the water main that runs through the structure, an excellent filter has been installed to furnish water of a quality suitable for drinking purposes.

Fig. 6 shows the ground floor of the practice house with the open doors of the gangways. Fig. 7 shows a part of the garret.

Panther Valley Mining Institute

The Panther Valley Mining Institute held its second annual banquet at Tamaqua, October 18. About 400 members were present. The speakers of the evening were: General Manager Edwin Ludlow, President S. D. Warriner, Prof. Preston Lambert, Attorney G. M. Roads and W. G. Whilden, President of the Institute. According to reports received, this affair was enjoyable and the speeches good. Owing to the lack of space, only abstracts can be given.

Mr. S. D. Warriner, when called upon, said: "Gentlemen of the Panther Valley Mining Institute, I have been quietly absorbing your hospitality, that is, eating a year's annual dues.

"The hospitality of the Lehigh Coal and Navigation Co. is of long standing, as may be ascertained by reading the minutes of the Directors' meetings, which occurred sometime between the years 1830 and 1840. At this time all the details of the operations were handled by the Board of Directors, and in looking over the early records which told of the difficulty of opening the mines in Panther Creek Valley, of the difficulty of loading the coal mined into boats at Mauch Chunk and sending it down to Philadelphia, I found the following resolution:

"Whereas the work of loading this coal on the boats is very burdensome, and whereas the Board of Directors in view of the long hours that the men are at work (15 to 16 hours at that time), therefore be it

"Resolved, That at proper intervals during the day proper supplies of malt liquors be dealt out to all of the men at that place."

Conditions today are different from the time when Asa Packer worked as a boatman on the canal, for now the Lehigh Coal and Navigation Co. ships more coal in a day than was then shipped in one year. It required education to bring this about, and while the company cannot give you an education, it will assist you in obtaining one; for what helps

you helps the company. I am unable to say what the company will or can do for you, but I want you to tell what you think you deserve and then it will meet you on a straightforward business basis and it will do what is right as a man to man proposition."

Mr. W. G. Whildin said: "Gentlemen and members of the Institute, we have met to mark the second year of the opening of the Panther Valley Mining Institute. Last year we predicted that by this time we would have two thousand members, but we were wrong. However, we expect this year to make good, and it is up to the members to help increase the membership.

"During the year we held monthly meetings at which papers were read that dealt with first-aid work, mine ventilation, methods of mining mammoth bed, transportation, electric haulage, and coal geology. We are going to repeat these monthly meetings this year, and the first one will be held November 15. Last year our institute school opened on the 15th of November; this year it opened on the 28th of October, the Lansford High School being the place of meeting.

"The four departments in the school are, primary department, mining, electric, and mechanical departments. There were fifteen members of the mining department school who took examinations this spring for mine foremen and assistant mine foremen certificates, and every one of those fifteen passed. Seven of these fifteen are now filling positions as a result of their being ably qualified to hold these certificates."

George M. Roads, Esq., of Pottsville, said: "Members of the Panther Valley Mining Institute and gentlemen—

'When their comrades are in danger,
Without thought of praise or gain,
The faithful boss and miner
At their posts will all remain.'

"It is that sturdiness of character, brought about by the dangers of your daily occupation, that makes a gathering of mine workers so sociable to anybody who may have something either serious or comic to say.

"It did me good to hear with what enthusiasm you sang 'America,' and it recalled a clipping taken from the *Philadelphia Press* on June 30 last, which is a reprint of an article printed 50 years ago June 30; this is it:

"'Mauch Chunk, June 30.—The Lehigh Coal and Navigation Co. offers to continue during their absence, the wages of such of their employes at Mauch Chunk on their lines of work, as will enlist in the military service of the State, and reinstate them in their positions when they return. The Board of Managers have also placed $5,000 at the disposal of the Superintendent and engineers, to be used to encourage the enlistment of men not in the company's employ.'

"I thought that the spirit of the Lehigh Coal and Navigation Co., in the days of '61, was incarnated in its employes when you sang that hymn.

"The preamble of your constitution sets forth the object and purpose of your organization, and it is twofold. First: To advance the welfare of the men employed in and about the mining industries of the anthracite fields. Secondly: To advance the interests of the industry itself.

"Did you ever think what education means in dollars, in comfort, in opportunities, and in convenience?

"Let me trace the history of labor. In the early centuries labor was slavery; then, as time elapsed, it received certain privileges. For a while in England, labor was permitted in the agricultural period to lease and cultivate the land, but upon the death of the lessee the land reverted to the owner, and the laborer's toil passed away so far as his posterity were concerned. As education and civilization progressed, the community said that is not right; we will grant the right to will the land he had cultivated, into which his labor had gone, to his children, and so labor advanced step by step. According to the great historian Macauley, the remuneration given to labor in 1685, was $1 per week without food in the summer, and 81 cents per day without food in the winter. A little creature 6 years of age was considered fit to work at the looms in Norwich, England. Wheat brought $2.17 a bushel, and the prices of clothing, of salt, sugar, and the other articles he enumerates, were higher in that century than when he wrote in 1845. The tradesmen received from 6 cents to a shilling a day, but the latter wages were extraordinary and exceptional.

"He goes on to say that out of the 800,000 families who labored in England, 400,000 had meat once a week, and the other 400,000 either had no meat, or only occasionally. He says further, that one-tenth of the entire inhabitants of England received relief from the parishes, and that it took 123 years for labor to obtain these wages.. This sketch shows you how labor and wages advanced step by step, until at the present time it is at its highest. When you assemble and organize for education of the mine worker you are doing your share to advance this great ongoing movement.

"It seems to me it would be better for labor organizations to have schools to instruct their members as to what they ought to do than to formulate demands about buttons in order to compel men who do not want to join their union to do so. It would be of immense advantage if they would open schools and teach these men what the law is; teach them what disobedience means and where the danger lies; teach them that while they may do a thing nine times, the tenth time it may be fatal; teach them to obey the law in regard to mining operations; teach them to obey the regulations of the mine owner for their own and for everybody else's safety.

"Now the other cause for which you have organized is to advance the industry of mining.

"During the negotiations between the mine owners and the leaders of the labor organizations toward the settlement of the strike in 1902, this statement was made: 'A miner

goes into the mines and works 4 to 6 hours; after he had cut sufficient coal to return him $2.50, he leaves his work and goes home, and it was asserted there in writing that one of the companies lost by this kind of labor 12½ per cent. of the total product that its mines were capable of producing. That is a very great loss and one which comes within the second purpose of your organization. There may be a hundred other ways in which you could improve the output of the mines. You know what it means to deliver air to the man who works in the mines; you know whether a man can work better and do better and produce better results if he has good air than if he has not."

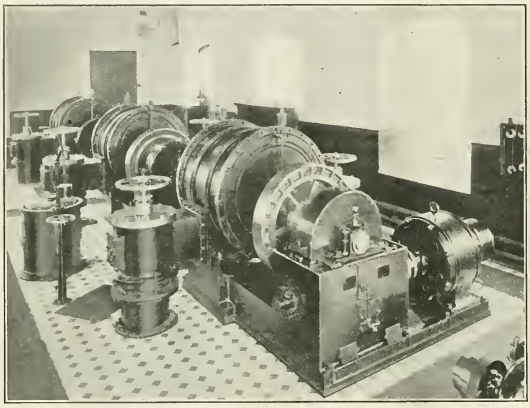


Fig. 1. Gas Exhauster

Accident With a Benzole Locomotive

By Ziebarth

In front of a pillar-and-post working place at the Rossleben Potassium Salt Mines, eight workmen were rendered insensible by fumes from a benzole locomotive. One of them died. Investigation showed that the accumulation of gas in part came from the benzole locomotive, the machinery of which had been running disconnected for about an hour. Owing to a loose screw in the mechanism which produced the ignition, the latter frequently missed, and this benzole flowed into the workings. Meanwhile a ventilator intended to assist the current had, owing to insufficient supply, drawn air through an untight brattice, instead of round it, and thus produced a short-circuit. Carbon monoxide gas, which issued in small quantities from the salt, had also collected, and the two gases, benzole and carbon monoxide had together overcome the men. The running of gasoline locomotives in mines without load is to be avoided in future as far as possible. Care is to be taken that, in carrying the air-current to remote places in connection with brattices, at least the quantity of air suitable for the operation is provided.

Gas Exhauster for Coke Ovens

Written for The Colliery Engineer

The extending use of by-product coke ovens involves a number of interesting features; among them being the removal of the gas from the ovens as fast as evolved and making it traverse through the various conduits, condensers, and washers necessary for the recovery of the by-products.

At the coke plant at Bargoed,* South Wales, belonging to the Powell-Duffryn Steam Coal Co., there is an improved rotary exhauster driven by a motor, as shown in Fig. 1.

There are several problems connected with the use of exhausters which must be understood in order to appreciate the conditions under which the machine must work.

If the exhauster works too fast there will be a tendency to draw outside air into the oven, thus causing a loss in coke by combustion, and also making a poorer quality of gas and fewer by-products.

If the exhauster works too slowly the gas evolved will have sufficient pressure to work through cracks in the door or possibly into the combustion chambers and be lost. Such conditions naturally demand an exhauster sufficiently powerful to overcome the friction due to the pipes, washers, and other by-product apparatus, but it should not be worked so as to create a vacuum in the ovens and to avoid this a regulator, shown to the left of the valve stand in Fig. 1 and in section Fig. 3, is required.

The Beal rotary exhauster was patented as early as 1866, but since then has been improved in so many different respects that it is termed the Bryan-Durkin exhauster. In Fig. 2, *a* is a part of the gas main or intake of the exhauster, and *b* a part of the gas main or the discharge of the exhauster. The machine consists of a cylinder *c*, in which a drum *d* revolves, on a fixed axle or gudgeon *e*.

Inside this drum there is a slide *f*, carefully arranged so as to move in notches *g* of the drum and also to move along the block *h* centered to the cylinder by the pin *i*.

As the drum revolves, the slide *f* being eccentric to it, also revolves and by means of nose pieces *j* forms a practically gas-tight compartment between the circumference of the drum and the walls of the cylinder.

The gas coming in through intake *a* is moved around and discharged through *b*. The slide, it will

*The Colliery Engineer, June, 1913, page 613.

be noticed, divides the cylinder into two compartments; one taking in gas while the other is discharging. Very little wear takes place in the exhaust cylinder as the movement of the blades is guided by the central block in conjunction with the axle and the only pressure on the cylinder is that due to the springs under the packing strips or nose pieces *j*.

Machines of this type are found in practice to be efficient in pumping gas against high pressures, as a heavy pressure against both surfaces of the slide is directly taken by the drum forming the driving member of the machine and at the same time adequate wearing surface is provided for the increased load involved. In some cases three or four-blade machines are used, as at slow speeds the fluctuation in pressure at the inlet side during the revolution of the exhauster is reduced by the increase in the number of blades, but the use of retort-house governors relieves a very considerable difficulty in connection with such fluctuations.

In Fig. 2, the cylinder is bored to such a shape that the vertical diameter is equal to the chord struck horizontally through the center of the drum, and therefore below the center of the cylinder. This allows a double-ended slide to be used, one

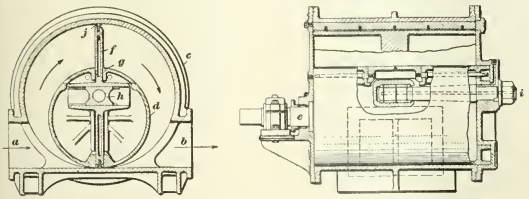


Fig. 2. Exhauster for Gases

piece eliminating friction which would be caused if the slide consisted of two parts, one sliding relatively to the other. The drum is cast in one with the driving shaft and is slotted to receive the main slide. It is turned true on the outside and just clears the bottom of the cylinder. The non-driving end of the drum runs in a race in the end plate, the inner diameter of this race forming the inside bearing which is easily lubricated. The main slide is cast in one piece with the guide bracket and has a slot at each end to receive the packing pieces or nose strips.

These exhausters are designed for working at comparatively high speeds consistent with minimum wear and tear. For small plants a moderate speed is arranged, gradually dropping with increase in the size of the exhauster until a speed of about 60 revolutions per minute is reached for an exhauster capable of passing 200,000 cubic feet per hour. The Powell Duffryn plant shown in Fig. 1, has three sets of exhausters each capable of passing 200,000 cubic feet of gas per hour. They are driven by electric motors through flexible coupling and cut worm-gear running in an oil bath. The motors are of 30 brake horsepower, and the pressure against which the exhauster works is from 30 inches to 40 inches of water when running at 85 revolutions per minute. To the left in Fig. 1 there is shown a bell governor so arranged that when the outlet pressure reaches a certain point the gas is passed back to the inlet. The general arrangement of this governor is shown in the diagram Fig. 3. The vacuum is regulated by by-passing the gas back again from the outlet to the inlet side of the exhauster, the valve *a* being of the rack and pinion type and is used for shutting the throttle valve *b* when necessary.

It is probable that in the very near future an enormous expansion will take place in the development of the coke-oven industry as directly applied to mining operations and it therefore behooves engineers to carefully study any advanced types of plant which are available for the development of an efficient and economical service and for this reason

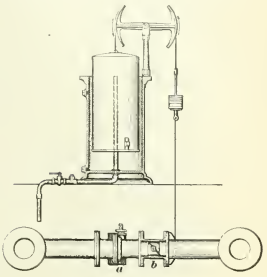


Fig. 3. Regulator

the above description of a large sized electrically controlled plant may be of value.

Hydraulic Stowing at French Collieries

By L. Gamzon

The first French collieries to employ flushing, were Lens and Bruay in the Pas-de-Calais; and in 1909 it was decided to apply the system to the Saint Eloi collieries, in the Puy-de-Dome, for protecting the principal winding shaft and preventing subsidence of its surface works. The flushing material consists of shale and sandstone, containing a little coal, from the workings; refuse from screening and washing; and clay, shale, and sandstone from the quarry, all of which passes through a 2-inch screen. They are conveyed by belts to hopper bins of large capacity, from which they are carried by a belt delivering 130 cubic yards per hour to the mixing hopper, where sufficient water is added to ensure the flow. The stowing is effected in layers, horizontal or inclined, a unit of void requiring 1.06 units of gobbing. During the first 11 months of 1911 as much as 53,191 cubic yards of void were packed.

The American Mining Congress

An Account of the Proceedings at the 16th Annual Session Held at Philadelphia, October 20 to 25, 1913

Written for The Colliery Engineer

THE sixteenth annual session of the American Mining Congress, which was held in Philadelphia, from October 20 to 25, was not so well attended as some previous meetings. The addresses were excellent and temperate, but lacked broadness, in that they were from local views for the greater part. This, of course, is natural, but owing to the principles involved governing states' rights and paternalism, local conditions cannot be well regulated.

MINERAL LAND LAWS

President D. W. Brunton delivered his address before a comparatively small audience, and those who heard it felt the need of a more vigorous policy on the part of the people of Colorado, if they intend to keep the goose which lays the golden egg. He said that if a prospector found a vein and staked out a claim he was immediately covered with adverse claims, and treated to a dose of litigation promulgated by people who had no right to a claim, and that neither revision nor repeal of the present mineral land laws will be an easy task, as the present apex side-line features of that law have proved a veritable mint for lawyers. He further stated that there was practically a smelting monopoly which not only tells the miner flat-footed what they will pay for ores, but in some instances just how much they will permit him to produce.

Mr. Brunton said that in the West just as soon as a farming community gains numerical strength sufficient to make itself felt in legislative halls, its first act is to place the principal burden of taxation on the mines. In Colorado the mines are now assessed at their entire cash value plus one-half of the annual gross output, plus the total net output, while the agricultural and fruit lands of the state are in many cases only assessed at from one-third to one-fifth of their actual market value. In Montana, Utah, and California the agriculturists have, by means of injunctions, closed up furnaces or obtained immense damages for mythical injury to crops. The Amalgamated Copper Co. has already paid out more money to "smoke farmers" than the whole valley could be sold for if the smelters were not in existence.

MINE TAXATION

At the morning session, R. V. Norris, of Wilkes-Barre, read a paper on the "Taxation of Coal Lands." The discussion of this paper was led by Prof. H. L. Smyth, of Cambridge, Mass. Mr. Norris said: "In actual assessment four methods of taxation have been attempted or suggested in Pennsylvania: (1) Valuation based on actual sales; (2) valuation based on footacres of coal remaining in the ground; (3) valuation based on royalty values; (4) valuation based on capitalized estimated profits.

"All of these methods have proved unequal and unsatisfactory." His conclusion was that "it appears that none of the suggested or attempted methods of taxation has resulted, or can result, in an equitable valuation, fair and just to both public and the owners of coal lands; that even moderate taxation of the coal in the ground is opposed to all principles of conservation, as its effect is to put a tremendous premium on rapid mining, almost regardless of ultimate recovery, to encourage the destruction of poorer and thinner beds interstratified with the better ones, on account of the enormous penalty entailed in slower mining, and to discourage by prohibitive penalties the holding of coal lands in reserve for the future necessities of the people.

"For these reasons it appears that the taxation of coal in the ground is logically and economically wrong, leading to the rapid and uneconomical exhaustion of the mineral wealth of the country, and putting a premium on premature and wasteful exploitation, and that the proper method of taxation for all minerals would be a tax based on the value at the mine of each year's product at the local rate of taxation assessed for that particular year, including an assessment on surface lands, outside improvements, and machinery, the values of which are readily ascertainable, but not including any valuation on mine openings or inside improvements which are incidental to the mining process and which, after exhaustion of the mineral ore, are of no value."

The next paper on the program was that of J. B. L. Hornblower, Comptroller of the Pittsburg Coal Co., on "Mine Costs." This paper caused a little discussion and was followed by an address by S. A. Taylor, Pittsburg, on "Uniform Requirements for Official Mine Reports."

Dr. H. M. Chance then read a paper on "Mine Taxation." Doctor Chance stated that "in the case of coal deposits it is a simple matter to determine values that bear some relation to the quantity and quality of the available or workable coal, yet in our mining districts throughout the United States we find an entire lack of system on the adoption of a practical and well-defined plan for fixing such values. Investigations recently made for the purpose of compiling data covering the principal coal fields of the United States, showed a lack of agreement in planning for assessing coal values for taxation. Not only is there practically no uniformity in practice between any two states, but we find entirely different methods used in the adjoining counties of the same state and even in adjoining townships of the same county; the principle that seems most generally recognized by the local assessors is one which requires an assessment to be so made as to be satisfactory to the tax payers of each district. Paraphrasing

a celebrated comment on the tariff, one is tempted to conclude that the assessment of mineral lands for taxation is a local issue."

ALASKA

W. R. Crane, Dean of the School of Mines, State College, Pa., read a paper on "The Coal Resources of Alaska." Doctor Crane stated that "at present the coal lands of Alaska lie untouched and the unlimited supply of fuels needed for the development of the resources of the country is withheld from its proper and legitimate use because of an obstructive policy rather than a constructive policy being forced on this far-distant territory. There are advocates for and against government owning and operating railroads and the leasing of coal lands. Of the former it may be stated that it is doubtful whether private capital would be very anxious to go to any great expense to provide transportation for the development of the coal fields and the handling of the coal under the present condition of the world's market. There are at present but two railroads in Alaska, and they do not connect with coal fields, although it was originally intended that they should, but that they will ultimately is not doubted.

"The leasing system is not altogether popular in Alaska, but could be made more popular by the elimination of some of the objectionable features. The principal objection to the leasing system, and one that will always conflict with the conservation policy, is the limited acreage of the lease, for small operations are uneconomical, and large operations require larger sums for equipment and larger holdings to guarantee adequate returns and permanency of investment. It is safe to say that an allotment of 320 acres could not be considered if the coal lands are to be open to competition. If the leasing system is adopted, it should be so framed as to encourage large corporations entering, and insuring efficiency in operation and reduction of waste. Government ownership of mines by a commission would undoubtedly mean efficient work and

Meeting of American Mining Congress, October 25, 1913

would conform to the broadest ideas of the conservation policy, but for some it savors too much of Socialism. It will probably be a long time before the coal mined in Alaska can compete in the world's market with the production of other fields, which are more advantageously situated; although when proper utilization has been accomplished, a market will undoubtedly open for them. However, if a constant supply of fuel can be assured to the home market at reasonable rates, the development of the vast resources of Alaska will be both sure and rapid, which will attract people and will undoubtedly lead to a permanent population and give permanency to investment."

Mr. David Ross, of Illinois, in commenting on the conditions in Alaska, stated that he had received a report from the Agricultural Department in Washington, which stated "that the crow was the friend of the farmer, and not his enemy; that the crow ate the egg of those birds which feed on the crops of the farmer." He said that he had "rather take the opinion of men who lived in Alaska on the conditions that existed there, than that of any of the agriculturists in Washington." After his speech, which was very interesting, a man from Alabama, told a story of a miner who, coming out of his hole in Alaska, and looking up at a stunted tree, saw a crow, thereupon he remarked: "You blamed fool, have you got wings, and will stay in a country like this?"

CONSERVATION

Hon. John F. Shafroth then gave an address on "A Western Idea of Conservation."

Senator Shafroth is an ex-governor of Colorado, and was in a position where he felt the money stringency in politics, because there was not enough available property for taxation. He said: "Everybody believes in conservation, but at the present, conservation means leasing the public lands, and that public lands are exempt from taxation, consequently the state will derive no benefit from public land in Colorado whose area equals Vermont, Massachusetts, Rhode Island, and Connecticut."

He said "that public land reservations were originally set aside for forestry purposes and to prevent snows from melting too fast, thereby holding back the water for summer irrigation purposes, but 40 per cent. of the reserves were above the timber line, 30 per cent. were in a neutral zone, where it took 200 years to grow a tree 19.6 inches in diameter, so that only 30 per cent. of the land set aside is of use for timber purposes."

He said "I have no objection to the government selling these lands for what they can get, but it cannot be that they can look upon our resources and prevent that development which occurred in the Western States previous to the adoption of this policy.

"There are 15,000,000 acres of government land in Colorado, from which we cannot get one dollar of revenue for state, county, or school taxes. There are 9,425,000 acres of coal land valued at from one-half billion to a billion dollars, exempt from taxation. The Geological Survey estimates the coal in Colorado to be 371 billion tons, 325 billion tons being on public lands, and if 10 cents royalty is placed on this, Colorado will contribute ultimately, $32,500,000,000 to the national treasury. At the present rate of consumption, Colorado has enough coal to supply the world for more than 300 years.

"Water falls from such heights in Colorado that a wonderful amount of electric power can be generated. The assumption of the conservationists was that the United States owns the waters, but they were shown a Supreme Court decision to the effect that the state owned the waters. That momentarily checked their plans, but they finally advanced the proposition that the Federal Government owns the land where the power plant is to be located. These waters belong to the state, and to hold up a state in this way is to deny the very indicia of sovereignty of the state. Here are water powers going to waste, and there is not a single water-power plant being constructed in Colorado, because the government policy has been to charge royalty. The people of a state are more careful of their rights than the National Government. I feel that Washington has no right to control Colorado."

Senator Shafroth's address was an excellent plea from the standpoint of states' rights and one which should be read entire by the people in the East.

Under the head of "Plain Talk," George Otis Smith, Director of the United States Geological Survey, stated some interesting things. Among them, he said, "Whatever the forum selected for public discussion in America, it evokes more language than ideas. Plain ideas are dressed up in borrowed or imported finery with all the tender care that a fond mother lavishes upon her little girl going to her first party, so that the practical man, who knows the work-a-day world, delivers an address conspicuous for the elegant words that completely envelop and conceal plain facts and solid opinions that deserve better treatment. Plain talk is more becoming than oratory to a time like the present. Vital issues, real and not fancied, bring us to know our friends. This arises from the interest in our country and ourselves. The exact distribution of this interest varies somewhat with the individual, but all of us are very much alive to whatever affects the welfare of ourselves and our fellows."

Mr. Charles R. Van Hise, President, University of Wisconsin, delivered an address on the "Relations of Big Business to Industry and Prosperity, with Special Reference to Mining." This address we expect to print later.

Unfortunately, but in good faith, he quoted the erroneous statement made and circulated by J. A. Holmes, Director of the Bureau of Mines, "that 50 per cent. of the coal in the anthracite fields was lost in mining." Mr. R. J. Foster, of Scranton, corrected this statement, saying

"it was absolutely false," and that very much more coal than that was recovered. He quoted several instances to prove it.

THE COAL MINING INDUSTRY

The address of John W. Boileau, on "What's the Matter with the Coal Mining Industry?" was read by proxy. Among the numerous important matters in this paper it was stated that "the real trouble with the mining industry is neglect on the part of those engaged in the industry, and particularly those members of the Mines and Mining Committee at Washington. Last month a congressman from Kansas resigned from the Mines and Mining Committee in order to become a member of the committee which affords more publicity and prestige. It is not generally understood that the mining industry is second only to agriculture in importance in this country. Agriculture as an industry is better understood, better entrenched, and better taken care of than mining. The Federal Government appropriations average about $24,000,000 a year for agriculture, and the states have given approximately, $11,000,000 more. The Federal Government has given to the mining industry about $1,000,000 per year and the states much less than this. In Congress there are always members ready to champion the cause of agriculture and membership on the Agricultural Committee is considered an honor. On the other hand, there are very few congressmen who understand anything about the mining industry and the Committee on Mines and Mining goes begging for a chairman or for membership on the committee.

"The attitude of Congress toward the mining industry is in sharp contrast to the industry's importance in Great Britain. Membership on the Mines and Mining Committee in Parliament is one of the highest honors a member can receive. The best men are selected for this place, and a debate on the mining industry serves to bring forth the entire membership and it becomes almost a national issue.

"Mining is not sufficiently recognized because there is a woeful lack of cooperation throughout the country. As a rule, the mining man in the West does not know the coal mine operator of the East, and the reverse, of course, is true. This lack of cooperation extends to many of the technical and trade papers. As an illustration, the technical papers, with one or two possible exceptions, when sent the prospectus of the meeting of the American Mining Congress, failed to exhibit any enthusiasm, which would lead toward a good meeting. Mr. Callbreath, the Secretary, wrote personal letters asking editorial comments on both events, and outside of two or at least three papers, these requests were ignored."

A. J. Moorshead, of St. Louis, delivered an interesting address in which he bemoaned the lack of interest exhibited by those present at the meeting, particularly when there was a large number present on the opening day, who failed to attend when President D. W. Brunton made his speech. Mr. Carl Sholz, of Chicago, also talked on the subject.

W. H. Fluker, Thompson, Ga., read an interesting paper on "Gold Mining in Georgia." There was no discussion on this paper, although, in our estimation there should have been. Dr. Erasmuth Howarth, Lawrence, Kansas, delivered an address on "Government Aid to Mining Schools." Hon. Martin D. Foster, Chairman House Committee on Mines and Mining, Washington, D. C., gave an interesting address on the

"FEDERAL GOVERNMENT AND THE MINING INDUSTRY"

There was no discussion on his remarks, which were mainly of a nature which told what he had done toward furthering the interests of the mining industry in the United States Congress and the difficulties which he had in obtaining appropriations for carrying on the work of mining.

He said: "Congress has been pretty liberal in appropriating money for worthy objects, and it must be realized that too often organizations go to the Federal Government for things that should be done by states, and the tendency to fasten upon the National Treasury for all time to come, many expenses that should be borne by the states, seems to be popular in the country now.

"The agitation for a mining department, which was started some years ago, principally by the metal miners in the West, finally resulted in the establishment of the present Bureau of Mines in 1910, the determining factor at the time being the series of explosions and consequent loss of life in the coal mines. Western mining interests, it is true, he said, did not receive very much benefit from the Bureau and have not yet been given the attention which they deserve.

"In the Sixty-second Congress there was appropriated $50,000 to begin the work in the metal mining sections of the country. This was but the beginning, and it is to be hoped that it will be the means of starting this work which will result in carrying it forward to greater results.

"The low-grade ores of the West have not been properly worked, for the reason that the individual has been unable to do so profitably. If the National Government could assist these people in finding some way of extracting the metal from these low-grade ores, it would be the means of adding millions to the wealth of the country. The government helps in agriculture, why not in the mining industry, which stands next in importance?

"The Bureau of Mines has lately taken up the problem of the conservation in natural gas. In the search for oil, natural gas has been allowed to escape into the air or been burned in the field where it was of no value. It is believed that the oil can be taken out of the ground and the gas so walled in as to leave it for future use when wanted. If the problem of saving this valuable fuel can be solved, it will add much to the wealth of our country.

"Let us hope that the research instituted by the Federal Government through the Bureau of Mines may be the means of saving to the people a large part of the coal now lost each year, and a large per cent. of the ores lost in metal mining, and the gases lost in the manufacture of coke. When we stop to contemplate the great loss going on from year to year, is it not enough to awaken us to the importance of expending a reasonable amount of money in the effort to stop this waste?"

Friday morning the report of George R. Wood, of Philadelphia, on the "Standardization of Electric Equipment in Coal Mines," was read, also consideration of the report of the Committee on Resolutions.

"ARBITRATION AS A FACTOR IN THE MINING INDUSTRY"

Was the subject of an interesting discourse by Hon. William B. Wilson, Secretary of Labor.

He said: "Mr. President and Gentlemen: The question of arbitration in any industry presupposes collective bargaining. I think it will be readily understood that arbitration with individual employes in large industries would be a practical impossibility, so that before you can enter into the arbitration of the questions in the mining industry, it must be entered into as a result of collective negotiations between the employes and the employers. Collective bargaining is the basis.

"Arbitration can only avail where there has been a failure of previous negotiations. That those negotiations entered into collectively are beneficial to the mining industry, I am thoroughly convinced. My judgment in that respect is arrived at from three phases of the situation. First, from the moral standpoint, second, from the business standpoint, and, third, from the political or legal standpoint.

"My conception of industry, particularly in its modern development, is that capital and labor are partners in production. Each performs a particular function in the production. Capital furnishes the machinery by which labor is made more productive. It furnishes in the form of a wage, the means by which the workman can live until that which he is working upon has been completed and marketed. These are the two important functions of capital. In other words, capital is the unconsumed products of previous labor, it is in a position to materially assist in increasing the productivity of labor, but labor itself is the vitalizing force that gives actual reproduction.

"Take capital, an inanimate thing and place it anywhere and it would remain there until time has turned it into dust before anything could be reproduced by it; but by performing the functions stated, it gives additional energy, additional force and effectiveness to labor, as I have said, being the vitalizing force, then the two are partners in production. Being partners in production then, from the moral standpoint, each is entitled to a voice in determining what the terms of the partnership will be; but how are they going to arrive at that determination upon an equitable basis? It can only be done by collective bargaining, and that is apparent to all who are engaged in large enterprises.

"When you stop to realize that the employe is but a very small unit in the operation, if you undertake to deal with the individual, and not with the collective employes, the employer has an immense advantage over him in making a contract. There is a ruling in equity that both parties to a contract must be of equal power, else the stronger party will take advantage of the weaker party every time. The only exception to that is where the generosity of the stronger party intercedes and causes him to yield that which he would not otherwise yield.

"Men do not engage in business through a spirit of philanthropy, but for the dollars and cents they are able to make; and even if they are of generous impulse, willing to treat with the individual employe, there is a point beyond which the generously inclined cannot go, unless those who are less generously inclined come forward also, so that from that standpoint as well, collective bargaining is a necessity in the mining industry.

"The only way in which the employe can be nearly equal to the employer in power in negotiating the wage contract or condition of employment, is where the employe acts collectively with his employer, then they are nearly equal in power in negotiating the contract, consequently, the contract itself is likely to be more equitable.

"In the long experience which I have had in negotiating wage contracts in the coal-mining industry, I think it was clearly demonstrated that it was not only beneficial to the employe, but beneficial to the employer as well, to engage in collective bargaining; and that brings me to the second phase of the problem which I want to deal with: that is the business advantage that comes from collective bargaining.

"I recall the time, and it is not so very long ago, when there was no collective bargaining in the coal-mining industry. Every employer and every employe was running upon his own hoof. The result was demoralization in the coal-mining trade. Operators were running on the lowest possible margin. They were seeking to compete for business—they are yet.

"They were running on narrow and uncertain margins. They were cutting down the wages of their workmen in the hope of being able to compete with some other man in the trade—the other man in the trade cutting the wages of his workmen in order to compete with the first, until a situation had arisen where there was neither wages for the employes nor profits for the employer.

"The business advantage that grew out of collective bargaining in the bituminous coal trade, was the stability that it gave to those narrow margins. Under the old method there was no knowledge of trade disturbances taking place. It is true that even in collective bargaining trade disputes arise, but not to the

extent of the old methods of bargaining. They never knew when trade disputes would arise; and as an outgrowth of that condition you will find in nearly all the contracts made today, a clause inserted, having a strike provision in them that grew out of the turmoil of that period.

"By entering into specific time contracts with their employes collectively, the result has been that those engaged in the coal trade are in a position to compute, within a fraction of a cent, what their costs are in production, and to know that these costs are continued at approximately that figure during the period of the time of the contract. They have thus been able to go into the market, knowing what the costs were going to be for a good length of time, and make their bids accordingly, so that from the standpoint of a business proposition, the stability that it has given to the trade in every line of industry, is of benefit to the employe, and to the employer.

"Now I come to the third phase, and that is the legal or political phase. It is a very common thing for employers to say—mining industry is no exception—'This is my business, and I propose to run this business without interference from any one.' That statement is based upon a narrow conception of our political institutions and the law of property. Originally in olden times, the man who had the physical power would take control of land, take control of property, and while he could retain that power, keep the property. In the olden times 'he would take, who had the power, and let him keep who can.'

"Our more modern conception of government, however, and the relation of government to property, is that articles to properties are conveyed, maintained, and protected, because society believes that is the best method of serving the welfare of society. It conveys a title and protects a title for all classes of property. There is not a piece of property in existence in the United States whose title is not a lawfully protected one. Society having perfected that title for its own welfare, may at any time modify or change that title, whenever in its judgment it is for the welfare of society to do so, and where you proceed along the lines that the property is yours to do with as you please, without interference by any one, and without recognizing the partnership of those who are engaged with you in production, then you are arousing and stirring up that sentiment which will ultimately lead to a change in our political affairs, a change in our theories of government, and change in the principles upon which titles to property rest. And so, from a legal and political standpoint, it is wise that we should proceed along the lines of recognizing that the employe is a partner in the production.

"I do not know of any way that I can better illustrate my idea of partnership than by citing an instance that occurred under my personal observation a number of years ago.

"We had been going on for about 30 years, dealing collectively with our employers (I was then a coal miner). We had an opportunity of meeting the manager of the company and presenting to him any grievances we had, and discussing them with him, and then presenting them to him in writing, and he would give a reply in writing, and through that process we arrived at a mutual agreement. A change in the management took place. The new manager had different ideas about handling property. We went to him with a grievance relative to dockage, discussed it with him orally, as we had been in the habit of doing before, and presented our grievance in writing and within a few days we received a reply couched in terms something like this:

"'This company has sent me here to run these mines, and I propose to run them without interference from any man or any secretary.'

"The committee received the communication and went before the balance of the workmen in their open union, and they discussed it, and finally came to the conclusion that the manager was thoroughly within his rights, that the state had conveyed a title to this property to the company and that it had a right to run that property in any manner it saw fit within the limits of the law, and having that right, it also had the right to delegate that power to any manager that it saw fit. And so they came to the conclusion that the manager was entirely within his rights in the proposition, and they sent the committee back to state so to the manager. The committee went back and they stated to him their position, and in addition added that so far as they were concerned, they would not interfere with him in the operation of the mine, and for 9 months after that time they did not interfere with him in the operation of the mine. Not a pound of coal was produced. At the end of the 9 months he sent for the committee, and he said he wanted his mines in operation. They said to him: 'Very well, put them in operation.' He said: 'I need miners to mine this coal.' They said: 'Very well, get the miners.' He said: 'I cannot get men as long as these miners continue their attitude.' The committee said: 'Do you want us to be partners with you in the mining of this coal?' He said: 'If you want to put it that way—yes.' A partnership was arranged and coal was produced. The workmen received their wages and the company received whatever profits there might be in the business under the new arrangement.

"Taken as a whole, as a means of giving stability to the business, as a moral right that the workmen and the employers have, a voice in the partnership, and as a political advantage, in my judgment, collective bargaining is the proper force. But it frequently occurs in collective bargaining that those who are immediately interested are unable to work out the problem, because that interest diverges at a certain point. Employers and employes have a mutual interest, not an identical interest (mark the distinction), in securing the largest possible production, with a given amount of labor.

That is true because there is a larger amount to be divided in the partnership, there is a larger amount ready for distribution between those who are partners. So they have a mutual interest in securing the largest possible production with a given amount of labor. The interest only diverges when it comes to a division of that which has been jointly produced. When that point has been reached, it seems to me the proper course to pursue is to sit down around the council table and work the problem out; but because of the divergence of interests, it will sometimes occur that the two parties are unable to come together, and it is not until that stage of the situation that arbitration comes into it. Then arbitration may properly come in—not compulsory arbitration, because compulsory arbitration means the opening up of the entire subject matters. It means conditions that are contrary to the spirit of our institutions and may lead to conditions that are contrary to the spirit of human rights. Compulsory arbitration if it means anything, means that the employer may be compelled to operate upon an award made by the Board of Arbitration that would lead to a loss and ultimately the wiping out of his entire capital, or it may, on the other hand, lead to employes being compelled to work under conditions that are onerous to them, that would be a species of slavery. Compulsory arbitration, in addition to opening up the entire field for consideration, creates a condition that is unfair to the employe, because in dealing with the problems before the board of arbitration, then the whole subject matter is thrown open, the employer is protected by a clean-cut dividing line between profit and loss, which can be shown by his records. He is protected in presenting his case before the board of arbitration, by that clean-cut dividing line, but the employe has no such clean-cut dividing line. The standard of living is flexible. It may be raised or lowered and the workman still live, so the workman has no dividing line to protect him, and the only arbitration that can be fair and just to all parties concerned is where both parties agree to abide by the result, a voluntary arbitration.

"When the negotiations under collective bargaining have failed, where the two parties at interest have been unable to get together, then they can properly submit the questions to a board of arbitration, and by that process leave the questions in dispute to a disinterested third party.

"The first method is where the problem has been jointly worked out, where both have mutually agreed upon the terms of employment. There is a better cooperation, which is of very great value in maintaining the efficiency of any plant, much better with the spirit of cooperation than remains when the subject matter has been referred to a third party, and that third party has made an award. It almost invariably follows that one side or the other is dissatisfied with the award that has been made in arbitration, so there is a spirit of unrest following the submission of a cause to arbitration. The better method is to handle it jointly, work it out jointly, if you possibly can, but failing in that, submit the problems in issue to a board of arbitration. In my judgment it increases the efficiency, it establishes stability that is an advantage to any industry that engages in that method of handling its trade departments."

Mr. S. D. Warriner, William Green, of Ohio, and others made comments on this address. Report of the Committee on Workman's Compensation was given by John H. Jones, Chairman, Pittsburg. Address on "Workman's Compensation Laws and Accidents, Prevention Work," were made by Thomas L. Lewis, Bridgeport, Ohio, E. T. Bent, Chicago, Ill., S. A. Taylor, Pittsburg, and David Ross, Springfield, Ill.

RESOLUTIONS

The following resolutions which have bearing on the coal mining industry, were introduced and passed:

No. 2. *Resolved:* That the mineral land law revision committee of the American Mining Congress be requested to confer with and, if possible, enlist the support of the American Institute of Mining Engineers, The Mining and Metallurgical Society, and all other kindred organizations in an effort to bring about such amendments to the mineral land laws of the United States as will inure to the benefit of the mining industry.—DAVID W. BRUNTON, Colo.

No. 3. WHEREAS, There are at present a great many different schemes and systems of valuation of mining properties for the purpose of taxation, and

WHEREAS, There is a tendency in many of the states to place an undue share of the burden of taxation upon the mining industry, and

WHEREAS, There should be some uniform system of valuation of mining properties for the purpose of taxation, therefore, be it

Resolved: That a special committee of the American Mining Congress be appointed to investigate and recommend a fair, uniform and equitable basis of valuation upon which taxes shall be assessed.—CHARLES E. MAURER, Ohio.

No. 4. WHEREAS, It is very desirable from all standpoints to have a more uniform system of mine reports both as to time of making the same and to the subject matter, therefore, be it

Resolved: That the Director of the Geological Survey and the Director of the Bureau of Mines of the Federal Government be requested to cooperate with the heads of the Department of Mines or the proper officers of the various states together with a committee of the American Mining Congress, in order to secure uniformity as to form and time of making mining statistical reports. —SAMUEL A. TAYLOR, Pittsburg, Pa.

No. 5. WHEREAS, This Congress has previously endorsed the principle of Federal Aid to State Mining Schools, therefore, be it

Resolved: That the American Mining Congress again urge immediate passage by Congress of legislation

providing for Federal assistance to the various State Mining Schools. H. N. Lawrie, Ore.

No. 6. Whereas, The Federal reports show the deplorable condition of the great coal industry of the United States and the small returns for the investment, as indicated by a paper read to this Congress by Edward W. Parker, Statistician of the United States Geological Survey, and

Whereas, Federal and state laws encouraging competition and preventing reasonable cooperation among those engaged in the production of this great natural resource, result not only in preventing a fair return for the investment of capital, and the risks involved, but in most cases allow only the recovery of from fifty to eighty per cent. of our buried heat, light, and power, the balance of which is irretrievably lost, and

Whereas, These laws limit the surrounding of the employes engaged in the extremely dangerous occupation of mining with all possible safeguards; therefore, be it

Resolved: That we urge upon the Congress of the United States and the State Legislatures, the necessity of the modification of the so-called "Antitrust" laws as applied to our natural resources, in order that they may be conserved and proper safeguards thrown around the employes, be it further

Resolved: That copies of this resolution and the address of Edward W. Parker to this Congress be sent to the President of the United States, to the members of Congress, and to the governors of the respective coal producing states of the Union. Charles E. Maurer, Ohio.

No. 7. Whereas, The pioneers of Alaska have, for many years, been appealing to the government for a more liberal administration of the public lands or for some new legislation which would permit the development of Alaska's resources; Whereas, The Congress of the United States has given consideration to these appeals, has conducted hearings before various committees, but thus far no legislation has been given, and the administration of the resources of Alaska by the Federal Government has brought about a stagnation of business, discouraging to the pioneers in that far-off territory and prohibitive of its best development, and

Whereas, Bills have been introduced in Congress which, in effect, recognize the fact that the construction of railroads into barren and undeveloped country cannot be expected except by the utilization of the enhancement of values of its natural resources, as a part compensation for the years of unprofitable operation, which necessarily accrue in the operation of a railroad in an undeveloped country, therefore, be it

Resolved: By the American Mining Congress in sixteenth annual session assembled, that we urge upon the administration of the Federal Government the best redress possible under the present laws or that such laws be speedily enacted, that private capital may be induced to interest itself in the development of the great natural resources of this territory.—William Maloney, Nome, Alaska.

No. 8. Whereas, The United States Internal Revenue Collectors of the various collection districts have placed different constructions upon the Corporation Income Tax law as regards the right of mining companies owning their land in fee to charge, as a part of the expense of production, a royalty or depletion charge, therefore, be it

Resolved: By the American Mining Congress that the Treasury Department be petitioned to issue uniform directions to its collectors in this regard, providing that a definite royalty or depletion charge be allowed as an item of the cost of production in arriving at the net income of mining companies for the purpose of taxation.—John E. Patton, Tenn.

No. 9. *Resolved:* That we express our sympathy with the relatives and friends of those who have lost their lives in the terrible explosion in the Dawson mine, and that we join the officials and owners of the Stag Cañon Coal Co., in regretting that all their efforts and forethought have, in some unfortunate and inexplicable manner, been rendered of no avail, and that the secretary communicate the matter of this resolution to the proper persons.—Dawson Hall, Brooklyn, N. Y.

No. 10. Whereas, The successful sixteenth annual session of the American Mining Congress, held at Philadelphia, October 20 to 25, 1913, resulted from the excellent arrangements made, and from the hospitality extended to the members of the Congress by the citizens of Philadelphia, now therefore, be it

Resolved: That the Congress hereby expresses its deep appreciation of the help and entertainment extended to it and its hearty thanks to all concerned including especially the local committees in Philadelphia, the Press and the citizens generally, with special praise to Messrs. Eli T. Connor and Daniel Whitney, and to the management of the Bellevue-Stratford Hotel.

The Congress also regrets that on account of illness, Mr. Connor was unable to participate in the proceedings, the success of which is largely due to his efforts.

No. 13. Whereas, The original purpose of the American Mining Congress was to bring about such cooperation between the Federal Government and the mining industry as would lead to its highest development, and

Whereas, The creation of a Federal Bureau of Mines has resulted in such great good to the mining industry, as to justify a demand for an extension of the work in this behalf, and

Whereas, The importance of the mining industry and its great need for the extension of the work which is now being done, justifies a demand for larger activity by the Federal Government, therefore, be it

Resolved: By the American Mining Congress in sixteenth annual session assembled that we urge upon the President and the Congress of the United States the enactment of legislation providing for a Depart-

ment of Mines and Mining, with its head a member of the President's cabinet, in order that the highest needs of the great productive industry, mining, may receive that attention from the Federal Government to which it by reason of its importance is entitled.—David W. Brunton, Denver, Colo.

DEMONSTRATIONS AND LECTURES

Demonstrations and lectures were carried on by the Bureau of Mines during the meeting of the Congress, in Horticultural Hall.

Monday, October 20, the Lehigh Valley Coal Co.'s prize-winning team at their first-aid contest in August, gave demonstrations, the Lehigh Valley Coal Co.'s rescue team also taking part.

Tuesday, October 21, rescue and first-aid demonstrations were given by the Susquehanna Coal Co.'s prize-winning team from the Mineral Railroad and Mining Co.'s district.

Wednesday, October 22, the Lehigh and Wilkes-Barre Coal Co.'s first-aid and rescue teams gave demonstrations.

Thursday, October 23, first-aid demonstrations were given by the Lehigh Coal and Navigation Co.'s corps.

Friday and Saturday, October 24 and 25, the Philadelphia & Reading Coal and Iron Co.'s rescue and first-aid teams gave demonstrations. In the same building there was an excellent display of mining machinery and appliances, the following firms having exhibition privileges:

EXHIBITS

Ackroyd & Best, Inc., Pittsburg, Pa., oil, naphtha, electric and acetylene mining lamps; safety machines for relighting lamps; magnetic unlocking machines; hardy rock drilling machine; boiler and oven furnace cement; car greasers, mining sundries.

Amalgamated Copper Co., New York, copper ores and bars.

American Tempering Co., Springfield, Ill., tempering process; small trip hammer, demonstrating dies in making and resharpening machine bits; small gas forge.

American Steel and Wire Co.

American Abrasive Metals Co., N. Y., Amco products.

American Concentrator Co., Philadelphia, Pa., coal and iron ore washing machinery; coal dryers; magnetic separators.

Atlantic Refining Co., Philadelphia and Pittsburg, Pa., manufacturers and marketers of petroleum products.

Baldwin Locomotive Works, Philadelphia, Pa., mine locomotive.

Ball Engine Co., Erie, Pa.

Bartlett & Snow Co., Cleveland, Ohio, complete working model of complete coal handling plant; Greene self-dumping car haul as erected at the Crow's Nest Pass Coal Co.

Cyrus Borgner Co., Philadelphia, Pa., retort and firebrick.

Commercial Museum, Philadelphia, Pa.

Cook's Sons, Adam, New York, N. Y., lubricating oils.

Davis Instrument Mfg. Co., Baltimore, Md., mining and scientific instruments; mining anemometers and hygrometers; safety lamp glasses.

Draeger Oxygen Apparatus Co., Pittsburg, Pa., rescue apparatus; Draeger resuscitation devices, including pulmotor.

Electric Service Supplies Co., Philadelphia, Pa., mine, railway and electrical supplies.

Edison Storage Battery Co., Orange, N. J., Edison electric safety lamps, complete with storage batteries and charging facilities; Edison storage batteries for operating locomotives.

Electric Storage Battery Co., Philadelphia, Pa., storage batteries especially designed for mining locomotives; typical plates and cells for this service.

Fairmont Mining Machinery Co., Fairmont, W. Va., steel ties; portable electric mine pumps; model of box car loader; railroad car retarder; power auger and bulletins.

General Electric Co., Schenectady, N. Y., electric machinery and appliances.

Goodman Mfg. Co., Chicago, Ill., mine locomotive, coal cutting machines.

Hazard Mfg. Co., Wilkes-Barre, Pa., wire rope and cables.

Hirsch Electric Mine Lamp Co., Philadelphia, Pa., Hirsch electric miners' cap and lamp.

Hyatt Roller Bearing Co., Newark, N. J., Hyatt roller bearings; mine car wheel with Hyatt roller bearings.

Jeffrey Mfg. Co., Columbus, Ohio, storage battery gathering locomotive, combination battery and trolley; heavy duty "Shortwall" mining machine and single-roll coal crusher.

Johnson & Johnson, first-aid and hospital supplies.

Justrite Mfg. Co.

Kueffel & Esser Co., Hoboken, N. J., mathematical and surveying instruments.

Koehler Mfg. Co., Marlboro, Mass., miners' safety lamps, igniters and electric exploders.

Lead Lined Iron Pipe Co., Wakefield, Mass.

Link-Belt Engineering Co., Nicetown, Philadelphia, Pa., elevating, conveying and transmission machines.

Lobdell Car Wheel Co., Wilmington, Del., car wheels and axles as applied to mine cars and mine locomotives.

Main Belting Co., Philadelphia, Pa., belting.

McChesney & Co., J. S., Chicago, Ill., mine supplies; wire hose tie.

Milburn Company, Alexander, Baltimore, Md., carbide cap lamps; carbide lanterns; portable lights for metal mines; oxy-acetylene welding and cutting apparatus; headlights for mine cars and locomotives.

Milwaukee Locomotive Co., Milwaukee, Wis., gasoline mine locomotives.

Phelps-Dodge Co., New York, N. Y., copper ores and bars.

Roebling Sons Co., John A., Trenton, N. J., wire ropes and cables.

Roessler & Hasslacher Chemical Co., New York, N. Y., cyanide of sodium; cyanide mixtures; present and proposed method of packing; caustic soda; metallic sodium.

Scott, John G., Girardville, Pa., rivetless manila transmission rope socket.

Smoke Prevention Committee, Philadelphia, Pa.

Street-Amet Weighing and Recording Co., Chicago, Ill., automatic weight recorder for mine tipple scales.

Troemner, Henry, Philadelphia, Pa., assay and analytical balances and weights of precision.

Universal Portland Cement Co., Chicago, Ill., use of cement in mining.

United States Steel Corporation, Bureau of safety, sanitation and welfare.

University of Illinois, Urbana, Ill., School of Mines Exhibit.

University of Pennsylvania, Philadelphia, Pa.

Vulcan Iron Works, Wilkes-Barre, Pa.

Western Electric Co., New York, N. Y., telephones; three wall instruments.

West Virginia Rail Co., Huntington, W. Va., steel rails.

Williams Patent Crusher and Pulverizer Co., Chicago, Ill., coal crusher.

Witherbee Igniter Co., Springfield, Mass., safety electric cap lamps.

ADDENDA

Whereas, Manufacturers of mining machinery and mining supplies were solicited to exhibit their productions, and

Whereas, Certain manufacturers did jointly and severally exhibit their wares at this session of the American Mining Congress, and

Whereas, The exhibition of said manufacturers' fabrications in the Horticultural Hall was to the advantage, education, and interest, of the members and of the delegates of this Congress, therefore be it

Resolved: That the Secretary extend to the said manufacturers in writing our most distinguished considerations for their assistance, and felicitations for their interesting displays, which did much toward making the sixteenth annual session one of success and profit to the mining industry.

34-5-5

Shaft-Gate Controlling Device

At the Nos. 1 and 2 mines of the Loyalhanna Coal and Coke Co., Loyalhanna, Pa., automatic safety-gate controlling devices are in use.

This device, invented by A. E. Giles, master mechanic and electrician of the company, differs materially from the ordinary shaft gates in that it neither lifts up or swings open, but slides to one side.

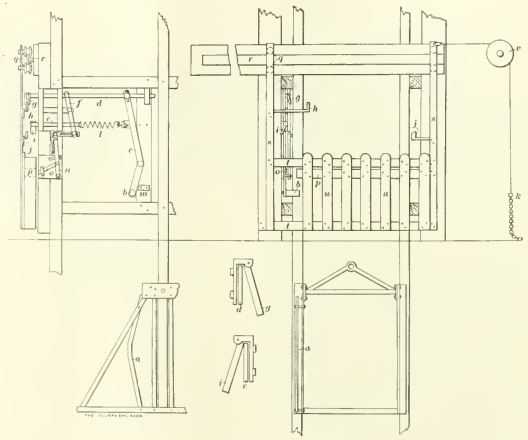


Fig. 1. Shaft Gate Controller

The action of this gate, with one exception, is automatic, the exception being at intermediate landings, where Mr. Giles believes all gates should be opened by hand.

The action of this device may be understood by reference to Fig. 1, which shows a front and side elevation of a shaft landing.

Assume that the gate is closed and locked with the cage above or below the landing, then when the cage approaches the landing, the bar *a* strikes the roller *b*, thus rocking the arm *c*. The bars *d*, *e*, and *f* are connected in such a manner that when the arm *c* is moved, it transmits motion to them, so that they withdraw the shutter *g* out of the path of the stop *h*, and at the same time place the shutter *i* in the path of the stop *j*. The gate may now be opened. The hanger irons *s*, to which the stops *h* and *j* are attached are made any desired length, and are fitted with rollers *q*, which rest on the horizontal track *r*. To the lower end of the iron hangers *s* are attached the bars *t* and pickets *u*, the whole forming the gate. To the right-hand hanger *s* at the top is attached a rope which passes over the pulley *v*, arranged at any convenient point, and attached to its end is a chain *k*, whose weight is sufficient to create a pull that will close the gate. The object of using a chain for weight is that as the gate closes, the chain strikes the ground, and the weight pulling on the gate decreases as the closing distance decreases, with the result that the gate comes to a stop with much less jar than were the weight a solid mass exerting its full force up to the time the gate closed.

In opening the gate, the stop *j* passes by the shutter *i* and when the chain *k* tends to close the gate, the stop *j* comes in contact with the shutter *i* and it holds the gate open.

The gate cannot now be closed until the cage leaves the landing, and the bar *a* having passed out of contact with roller *b*, the spring *l* acts on the bars *e*, *f*, and *d*, thus bringing the lower end of bar *c* into contact

with stop *m*. The shutter *i* is now moved out of the path of the stop *j*, and shutter *g* is moved into the path of stop *h*. This permits the chain weight *k* to come into action and close the gate; moreover, the stop *h*, having passed the shutter *g*, the gate is automatically locked.

Realizing that the action of the bar *a* against the roller *b*, due to the passing of the cage in hoisting coal would cause excessive wear, Mr. Giles makes use of an auxiliary locking device which prevents such wear but in no way affects the automatic action of the gate.

When it is desired to use the cage above or below the landing, but not at the landing, the lever *n* is pulled forward, thus drawing the roller *b* out of the path of the bar *a*, also shifting the shutters *g* and *i*, but at the same time moving the bar *o* into the path of the stop *p*, thus putting the automatic device out of commission, but locking the gate. By permitting the lever *n* to move back into its original position, the automatic device is again put into action. This may be carried out either when the cage is at or away from the landing. When the cage arrives at the landing the gate may be opened either from within or without, and is automatically held open. The cage leaving the landing, the gate automatically closes and is held closed.

A Pressure and Velocity Meter for Mines

In Great Britain the Coal Mines Act demands that a periodical record of the pressure (depression) of the air being circulated through the mine should be kept, and whilst measuring the pressure it is of course, a great advantage to be able to simultaneously measure the velocity of the air at the measuring place, and the volume passing. For this purpose Richard Cremer, of Leeds, England, has introduced a combined meter on which the pressure and velocity are registered on the same chart and can both be read at one glance. The meters, based on the hydrostatic principle, give the exact measurement of so low a gauge pressure as $\frac{1}{64}$ inch. The chief types of meters are those for measuring pressure or vacuum for a fixed measuring range, those dealing with different adjustable ranges of water, and those which indicate simultaneously pressure and vacuum. In the combined volume and pressure

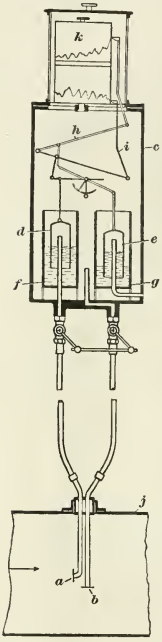


Fig. 1

meter the action is based on the simultaneous measuring of the pressure of velocity and static pressure, caused by air or gas currents. As shown in Fig. 1, the velocity pressure acts upon the vertical opening of a pipe *a*, while the static pressure influences the air in pipe *b*, which is parallel to the air-current. This apparatus contains in its air-tight casing *c*, two floats *d* and *e*, working instantaneously, to which the pressure acting upon the pipes *a* and *b*, respectively, is conveyed. They are separated by non-volatile oil contained in vessels *f* and *g*. The floats transmit their movements to pointers or registration pens, *h* and *i*, according to whether the apparatus is required with indicator or registration only, or with both together. The size and form of the floats are controlled by local conditions, such as the amount of the pressure and of the velocity.

The float chamber *d* is connected with the opening *a*, while that of the float *e* is connected with the atmosphere. The casing *c* communicates with the opening *b*. In the outer casing of the apparatus, therefore, the static pressure prevailing in the pipe *j* exists. In the float *e* the pressure of the atmosphere is acting and therefore the position will depend on the pressure or depression in the pipe *j*. In the float *d* the static pressure acts in addition to the velocity pressure, and the action on the float consists of the difference between the static pressure and static pressure and velocity pressure; that is to say, the velocity pressure. Both floats transmit the pressures to the pointers or writing pens directly, and thus indicate the pressure or depression (vacuum), or the velocity, respectively. Should a record of the volume be required, the scale *k* can also be so divided that the volume can be read or registered directly. The attendance for the meters is limited to changing the charts, which on the large instruments is only weekly. With normal use, dust, moisture, or corrosive gases cannot enter the apparatus, and owing to the workmanship, the meters have an extraordinary sensitiveness and accuracy. It will be seen that stuffingboxes or other joints causing friction are absent. Sticking or blocking of the floats does not occur, and immediate registration of any fluctuations in velocity by the apparatus is effected. The apparatus forms a useful means of controlling the ventilation in mines, and can be applied to such work as gas control in blast furnaces, iron works, coke ovens, etc., and also in gas works.

Electric Mine Haulage

Advantages of Electric Locomotives—Different Forms of Construction and the Conditions to Which They are Adapted

By Eric A. Lof*

THE electric locomotive is recognized as one of the most successful systems of mine haulage and possibly in no other branch, where electricity has been applied to mining operations has it met with a more thorough appreciation.

The electric locomotive has numerous advantages, beingable to cover extensive areas with large outputs. The electric locomotive is an efficient machine and the distribution of the power from the generating station to the various entries is effected by means of the overhead trolley system. The first cost, the maintenance, repair, and attendance charges are low. The control and operation of the locomotive is simple, and its rugged and durable construction makes it well adapted for mining work.

The design and construction of electric mine locomotives has reached a stage of perfection where breakdowns are of rare occurrence, notwithstanding the rough service to which they are subjected by careless and inexperienced operators. Accidents are of course liable to happen, but with the recent improvements in the design of these locomotives, all parts are accessible and can be interchanged or repaired.

The use of steam locomotives, especially for underground work, is objectionable on account of the gases and smoke evolved and the necessarily higher headroom required. Compressed-air locomotives are also poor substitutes, on account of their lower efficiency and limited radius of action due to their small storage capacities, except where the mine is gassy. Gasoline locomotives, also have their disadvantages in gassy and poorly ventilated mines. The mule, which has been one of the chief competitors of the electric locomotive is now being displaced by gathering locomotives, as the cost of hauling by electricity has proved to be considerably cheaper. The cost of feeding, the large percentage killed or injured, and the additional amount of air necessary for mules in underground work, are all factors in favor of the electric locomotive.

While alternating-current locomotives are used occasionally, the direct-current locomotive has come to be generally recognized as the standard for mine work. These furthermore have two-motor independent drives, which offer advantages over the single motor, mechanically connected.

Actual tests have demonstrated that two-motor machines will pull from 10 to 20 per cent. more than the single-motor mechanically connected machine. A higher efficiency is also realized due to the series or parallel control. In gathering work it is invariably required that locomotives be capable of operating at low speed. With the single-motor drive this can only be effected by keeping a large amount of resistance in series with the motors, which results in practically half the power input to the locomotive being wasted in resistance losses. With the two-motor drive, efficient speed regulation is obtained by the series or parallel system of control, low speed being obtained by running the motors in series thus eliminating the resistance losses. For a given drawbar pull with motors in series, the current consumption is half that taken by a single-motor locomotive, and the load of the power station during starting periods, etc., is therefore considerably reduced. Furthermore, should the motor of the single-motor locomotive break down, it would be crippled; while with the two-motor locomotive, one defective motor could be disconnected and the machine operated with the other motor; and although the capacity would be reduced, it would still be available for a large amount of work.

The overall width of a single-motor locomotive is at least 8 inches more than a two-motor machine, which is highly objectionable in underground mining work, where every inch of clearance must be taken into account. Not only would the props for supporting the roof have to be placed farther apart, but danger to the employes would be increased, unless plenty of clearance was provided for.

The general construction of electric mine locomotives involves two distinct forms, one in which the side frames are placed outside the wheels, as shown in Fig. 1, and the other in which they are placed inside the wheels, as shown in Fig. 2.

For a given track gauge the out-

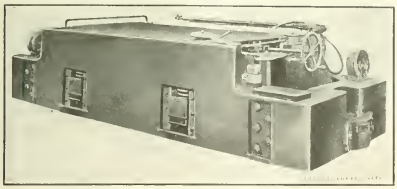


Fig. 1. Outside Frame Locomotive

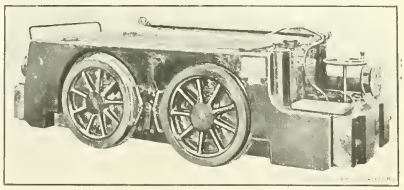


Fig. 2. Inside Frame Locomotive

*Schenectady, N. Y.

side frame allows the maximum space between the wheels for the motors and other parts of the equipment, renders the journal boxes more accessible, and gives somewhat more space at the operating end for the motorman. The inside frame restricts to a certain extent the space between the wheels available for motors and other equipment, but allows for the minimum overall width, a construction that is necessary in those mines where the props are set close to the track or the space outside the rails is otherwise limited. The wheels being outside the frame, this locomotive in case of derailment is somewhat more readily replaced.

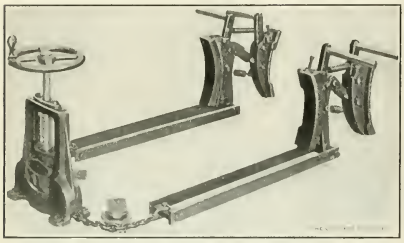


Fig. 3. Vertical Screw Brake Rigging for Outside-Frame Locomotives

There are two standard methods of mounting the motors: in "tandem," i. e., one motor placed between the axles and the other between the forward axle and the front end frame; and "central," i. e., both motors placed between the axles. The tandem arrangement permits of a short wheel base and is adopted for the light and medium-weight locomotives, as these are usually required to operate over sections of the track having short-radius curves. On the heavier locomotives the motors are mounted "central." The longer wheel base is permissible in this case for the reason that the heavy locomotives operate on the main haulage roads which, as a rule, are comparatively straight and have easier curves. With either arrangement the locomotive frame is proportioned to give an equal distribution of the weight between both pairs of driving wheels.

Motors may also be "end" mounted by placing each motor in the space between the axle and the forward and rear end frames, respectively. This permits the minimum wheel base, but is very seldom used, and is adopted to meet exceptional conditions only.

The locomotives may be supplied with side frames of cast iron or rolled steel plate, the latter construction being now the most generally used. The end frames as a rule consist of steel channels fitted with heavy wooden bumpers, except on large locomotives where cast-iron bumpers may be advantageous in order to get more dead weight. The bumpers and coupling devices must be designed to suit the mine cars, the standard combinations being shown in Fig. 5.

The weight of the locomotive is ordinarily supported from the journal boxes on heavy helical springs. The journals are somewhat similar to those on railway cars that have removable brasses and are lubricated from oil cellars filled with waste.

The construction of the journal boxes is such that the brasses can be removed without disturbing the axles or frame stay-plates. On outside frame locomotives this is accomplished by jacking up the frame to relieve the pressure on the journal box spring and removing two vertical retaining plates. The inside-frame journal boxes are fitted with a removable oil cellar which can be lowered for repacking.

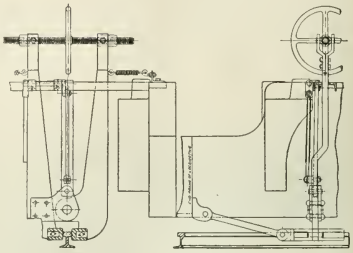


Fig. 4. Special Brake

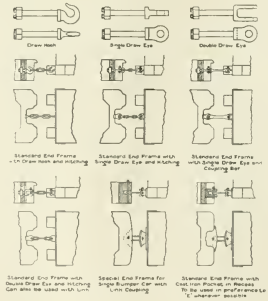

Draw Hook
Single Draw Eye
Double Draw Eye
Standard End Frame with Draw Hook and Hitching
Standard End Frame with Single Draw Eye and Hitching
Standard End Frame with Single Draw Eye and Coupling Bar
Standard End Frame with Double Draw Eye and Hitching Can also be used with Link
Special End Frame for Single Bumper Car with Link Coupling
Standard End Frame with Cast Iron Pocket in Recess To be used in preference to Wherever possible

Fig. 5. Standard End-Frame Constructions

Plate wheels are generally used for outside-frame locomotives, while for the inside-frame construction spoked wheels are used, in order to give access to the journal boxes.

Chilled cast-iron and steel tires or rolled-steel wheels are in general use, the first named being, however, the more common. These are approximately 60 per cent. cheaper than steel-tired wheels and 45 per cent. cheaper than those of rolled steel. The higher cost of the steel wheels is, however, largely offset by the fact that the treads can be refaced several times, if facilities are provided therefor in the repair shops.

A somewhat increased adhesion is generally realized by the adoption of steel wheels for mine service. While opinions differ greatly as to how much this really amounts to, it is generally conceded to be about 5 per cent. A considerable portion of this increased effort is often found to be due to the greater weight of such wheels, and a comparison is difficult to make, as both the wheel tread and rail are always subject to wide variations

caused by moisture, nature of the surface, amount and quality of sand used, etc.

Several kinds of brake mechanisms are in use. An exceptionally strong and efficient one is shown in Fig. 3. With this kind of brake the shoes are automatically locked in any position in which they are left by the operator without the use of pawls or ratchets.

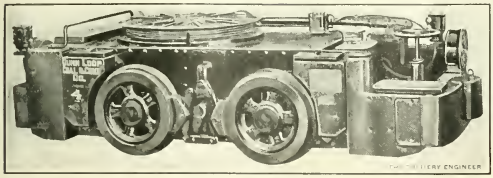


Fig. 6. Four-Ton Gathering Locomotive

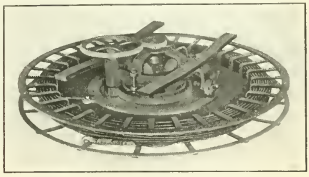


Fig. 7. Motor-Driven Cable Reel

The brake shoes, made of cast steel, are removable in order to insure a long life and in addition exert a dressing action on the wheel tread.

In certain instances where there is a heavy down grade, in order to be sure of controlling the loaded trains, a special rail grip brake is provided in addition to the usual wheel brakes. The mechanism and operation of such a brake is shown in Fig. 4. The jaws are arranged to press shoes against a third rail which is laid in the center of the track. This brake is powerful enough to stop a train within a distance of 100 feet on an 8 per cent. grade, the train weighing 100 tons, exclusive of locomotive, and running at a speed of 8 miles per hour.

Sand riggings are always provided, and the sand boxes so arranged that the rails may be sanded ahead, when running in either direction.

In the design and construction of mine locomotive motors, the following requirements are essentials: Maximum capacity within the gauge limitations; large overload capacity; accessibility for inspection and repair; large bearing surface to minimize wear; protection against dust and moisture; accurate machining to insure interchangeability of parts; rugged construction to withstand rough usage.

The motors are always of the series type and should preferably be equipped with commutating poles. In this kind of motor the same current passes through the main-series and commutating-pole field coils. The torque exerted and the speed at which it will run, depend upon the flux entering the armature, the number of conductors on the armature, and the amount of current flowing in the winding. The flux in turn depends on the strength of the field magnets, which in their turn depend on the number of turns in the field coil and the amount of current flowing therein. The advantages of the commutating poles which are connected in series with the armature lie in the fact that the electrical and mechanical neutrals are made to coincide for all loads and for either direction of rotation, thus assuring good commutation under all conditions of operation.

The motor frames are split diagonally so that the upper part can be lifted off, exposing the interior for inspection. The bearing heads are securely clamped between the upper and lower frames, making it possible to readily take out the armature for repairs. The laminations, armature windings, and commutator are all mounted on a common spider so that the shaft may be removed without disturbing them, and interchange can therefore readily be made.

The armature bearings are commonly of the Babbit-lined bronze sleeve construction, designed for oil and waste lubrication. The Babbit is of such a thickness that should it be melted from lack of lubrication, the shaft will be supported by the sleeves before the armature strikes the pole pieces.

The use of ball bearings in mine locomotive motors is a new feature. Where they have been tried, they have given excellent results, and at the present outlook they bid fair to displace the plain bearings for this class of service. The principal advantage gained by the use of ball bearings is the small amount of lubricant required. This lubricant being vaseline or some similar grease in small amounts, there is very little possibility of its getting into the motor windings. There is a great advantage in this, as a large percentage of the motor troubles can be traced directly to oil having worked its way into the windings. When properly lubricated, ball bearings have another advantage, in that there is but a small amount of wear. This decreases the liability of the armature coming down on the pole faces with damaging results.

The field coils are held securely in place by spring-steel flanges, which are pressed against the coils by the pole pieces when the latter are bolted in place.

The controllers are of the rheostat magnetic blow-out kind. A commutating switch is incorporated in the reverse cylinder, the handle of which has four "on" positions, two for each direction of motion, one with motors in series and the other with motors in multiple. The main and reverse cylinders are interlocked in the usual manner and the main cylinder provides for speed regulation with motors in series or multiple. This system of control, by permitting motors to be started in multiple, allows them to exert their maximum tractive effort independently, so that the slippage of one motor does

not affect the other—a valuable feature for starting heavy trains.

When the operating handle is in the "off" position, all parts of the motor and rheostat equipment are "dead" and it is also impossible to retard the train by "bucking" the motors—a practice of motormen that is liable to cause trouble.

while the lower one, which is made of a composition of magnetite, lasts from 50 to 75 hours.

While mules are still largely used for the purpose of gathering loaded cars from the working faces of the coal mines and distributing empty cars to replace them, the use of gathering locomotives for this service desired to open the circuit. A permanent resistance is also inserted in this circuit in order to limit the heavy rush of current which would take place when the locomotive is standing still. The motor, however, has sufficient capacity to permit its being stalled for any length of time without overheating.

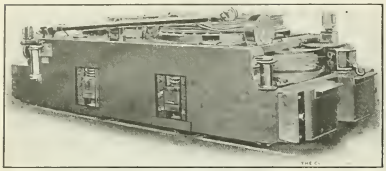


Fig. 8. Combination Locomotive With Motor-Driven Cable Reel and Steel-Cable Hoisting Drum

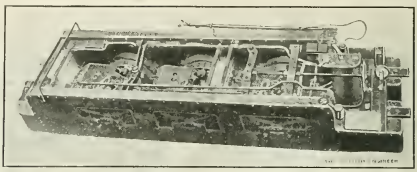


Fig. 9. Fifteen-Ton Three-Motor Locomotive

The trolley shown in Fig. 1 is most extensively used and has come to be adopted as the standard mine trolley. The wheel is mounted in a swiveled harp which permits it to aline itself with the trolley wire, irrespective of the direction of the pole. The pole is of wood and the lower end is inserted in a swiveled base which fits into sockets on either side of the locomotive. The force of the compressed spiral spring is so applied to the pole that the pressure of the trolley wheel against the wire is approximately uniform throughout the limits of vertical variation and the swivel harp permits a wide lateral variation of the wire. The pole being of wood is thoroughly insulated, and is so located that the motorman can easily handle and reverse it without leaving his position. The trolley cable terminates in a contact plug which fits in a receptacle placed on each side of the locomotive, so that the change from one side to the other is readily effected.

The headlights provided at each end of the locomotive, are usually each fitted with a 32-candlepower incandescent lamp which gives sufficient illumination. A luminous arc mine headlight is, however, manufactured, whose mechanism is simple and requires little attention. The upper electrode is made of copper and lasts from 2,000 to 3,000 hours, is becoming common. This is not only due to the higher maintenance cost of the slow mule haulage and the fact that one gathering locomotive can readily do the work of a number of mules, but also to the fact that entries with less headroom can be used, thus permitting the working of thinner coal seams without additional cost for brushing the roof or taking up the bottom to make mule haulage possible.

The gathering locomotives are generally smaller than those used in the main entries. They are provided with a cable which can be connected to the trolley wire in the entries and through which power can be fed to the motors when the locomotives enter the rooms. This obviates the use of trolley wires in rooms and the danger of the workmen being shocked.

The cable is wound on the cable reel, mounted on the top of the locomotive frame, shown in Fig. 6, and rotates on a ball bearing between the main gear and the top of the motor. The reel is driven through a double-reduction gearing by a small, vertical, series-wound motor, shown in Fig. 7, the armature of which is as a rule provided with ball bearings. The motor is connected directly across the line, with a fuse and a switch inserted in the circuit, the former to protect against short-circuits and the latter in case for some reason it should be

The cable is generally about 500 feet long and made flexible and heavily insulated to withstand the wear to which it necessarily is subjected. The inner end is connected to a collector ring on the underside of the reel and the outer end is fitted with a copper hook for attaching to the trolley wire. A carbon brush mounted on an insulated stud attached to the motor frame collects current from the ring from which it is conducted to the controller circuit. When it is desired to run the locomotive in a room, the end of the cable is attached to the trolley wire at the room neck, and the locomotive is operated by the current collected through the reel of cable mounted on the locomotive.

The arrangement and design of the reel motor is such that at all times it will produce a tension on the cable. Thus, as the locomotive moves forward the counter torque will produce a tension in the cable and cause it to pay out evenly and drop along the roadbed without kinks. Owing to the braking effect of this counter torque, the reel will also come to a standstill when the locomotive stops; and as it starts on the return trip and the cable is slackened, the motor action will immediately come into play and the reel will commence to wind up the cable as the locomotive moves along, the peripheral rim

speed of the reel being higher than the linear speed of the locomotive. The operation of the reel is thus entirely automatic and requires no controller, ratchet, or clutch to be handled by the motorman, but leaves the motorman free to give his entire attention to operating the mining controller and brakes of the entire running of the locomotive.

Gathering locomotives are also generally equipped with a regular mine trolley so that they can be used in the same manner as regular hauling locomotives. When the cable reel is not being used and the locomotive is collecting current through the trolley pole in the regular way, the current flow through the reel motor is cut off by throwing the reel and trolley switch to the "trolley" side.

Locomotives with hoist drums are used in portions of many coal mines, especially in the Southern soft-coal fields, where the coal bed dips very sharply, and the tracks leading from entries to the working faces have steep grades, sometimes 20 per cent. and more. The only system that can be used on a grade of this kind is rope haulage, and a hoisting drum therefore proves a valuable addition to gathering locomotives.

When so equipped, the locomotive can be blocked on the track in the entries, and by means of the hoisting cable, cars can be hauled up or lowered from the working face of the rooms. The hoisting drum is preferably operated by a separate motor.

An 8-ton combination gathering locomotive equipped with a motor-driven electric cable reel and a motor-driven steel cable hoisting device is shown in Fig. 8, and when a locomotive is so equipped, there is hardly any proposition in the haulage line that it cannot meet.

In the early period of electric mine haulage, some 10 or 12 years ago, a mining locomotive was generally considered satisfactory so long as the motors could develop the torque required for the necessary traction. Heating was then not the limiting feature, due to the short and infrequent runs. The headings have, however, as the years have gone by, attained considerable length, in many mines up to 6 or 7 miles. The motors which formerly were good for short runs of 1 or 2 miles have consequently become entirely inadequate for the longer runs unless the loads are correspondingly reduced. Such is out of the question, for, the longer the runs, the larger the trains must be, and consequently also the necessary motor capacity. The space which these locomotives can occupy is however limited by the track gauge, and the only way to further increase the hauling capacity is either to run two locomotives in tandem or to use three-motor locomotives.

The weight of a large two-motor locomotive may furthermore be prohibitive due to the track construction. On well-laid tracks having 50- or 60-pound rails, 25- or 30-ton four-wheel, two-motor locomotives will operate successfully, but where lighter rails exist, it is inadvisable to concentrate the weight on four drivers. Instead, therefore, of using a single 20-ton locomotive, two 10-ton locomotives coupled in tandem may be used, because while developing the same tractive effort, with this combination the weight will be distributed on eight driving wheels.

Cases are on record where large sums of money have been saved by the use of tandem locomotives, where the increased lengths of hauls or tonnage necessitated larger locomotive capacities. In one particular instance it would have been necessary to widen the tunnel for many miles, while in another, several miles of track would have had to be relaid with heavier rails. It is extremely simple to couple the locomotives in tandem.

The first or "primary" locomotive is provided with a four-motor controller and the second, or "secondary" locomotive, with a two-motor controller. The two are electrically interconnected so that there is a complete control of all the motors from the operating end of one.

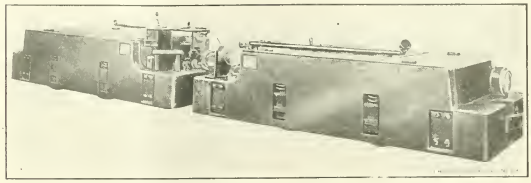


Fig. 10. Two 10-Ton Locomotives Coupled Tandem

Similarly the brakes and sand valves of both locomotives can be operated from the same place.

The locomotives can also be operated singly as independent units by separation, which requires but a few minutes, and only involves the pulling out of the cable plugs, disconnecting the brake chain, and turning the "primary" brake stand parallel to the end frame.

In Fig. 10 two 10-ton locomotives are shown coupled in tandem.

Instead of tandem locomotives, six-wheel, three-motor locomotives of 15 to 25 tons capacity may, to a certain extent, be used for the long and heavy runs over the main road. Their application is, however, more or less restricted, as on account of their greater length they may not take the sharp curves usually found in mine work. Where this is not objectionable, locomotives of this kind have advantages, one being the possibility of using lighter rails than for a two-motor locomotive of the same weight, due to the equalization of the weight on all three pairs of driving wheels. To insure this, irrespective of any irregularities of the track, three-motor locomotives are supported from the journal boxes, thus insuring at all times an even division of the load among the three motors. The equalizing system also furnishes a flexible suspension of the weight and produces an easy running

locomotive, greatly minimizing the wear and tear on the track and roadbed. The center pair of wheels are generally furnished without flanges so as to prevent any binding at the curves.

Fig. 9 shows a three-motor locomotive with the equalizing springs above the journal boxes.

Alternating-current locomotives are used rarely in this country, and few three-phase systems have been installed. These locomotives are of the same general construction as the direct-current locomotives, and are equipped with two three-phase, polar-wound, induction motors They are inherently practically constant speed machines, but with the variable external resistance in the rotor circuit a speed and torque characteristic somewhat similar to that of the direct current series motor is obtained. A double reduction gearing is required, due to the inherently high speed of the motor.

In operation these locomotives require two overhead trolley wires, with the track rails comprising the third phase. To collect the current, two trolleys are required one mounted on each side of the locomotive

(To be Continued)

Taxation of Anthracite 70 Years Ago

Through the kindness of Baird Halberstadt, mining engineer and geologist, of Pottsville, Pa., we are enabled to present a peculiarly interesting letter on the matter of taxing anthracite coal, written 70 years ago, by Hon. Francis W. Hughes, of Pottsville, to his personal friend, Hon. David Porter, then governor of Pennsylvania.

The writer of the letter, Mr. Hughes, will be remembered by many of our oldest readers as an attorney of national reputation, and by some who knew him personally in his later years.

It appears that at the time the letter was written, there were grounds for the belief that Governor Porter would recommend a state tax on anthracite to secure funds to help pay off the then state debt. Mr. Halberstadt, in addition to his professional work for clients, is greatly interested, both in the geological features and the mining history of his native county (Schuylkill), and in the course of his historical researches, he secured the letter, of which the following is a copy:

Pottsville, Nov. 24, 1843

Gov. David R. Porter,

Dear Sir:—Some fears are entertained by many persons in this County that you will recommend in your message at the opening of our next Legislature, a tax on coal. It may be that these fears are groundless—I hope they may be so—I would admonish you against this measure if you have any idea of it. There are many most substantial objections against it.

First. Is it constitutional? Does such a measure not "lay a duty upon exports?"

Second. Would not this tax be strongly objected to by consumers in other states and would it not afford good ground to apply to Congress to repeal the duty imposed on foreign coal—a duty vitally important to the success of the coal interests of Pennsylvania?

Thirdly. Would not this tax be partial and unequal, and therefore most unjust in its operation, especially when we reflect that this tax would be levied on account of our state debt and that in Schuylkill County (the most important coal county in the state), very little or none of the money for which the state debt has been incurred has been expended?

Fourth. The coal and iron interests of Pennsylvania constitute our principal products, upon which Pennsylvania must rely to maintain her position to the other states. Would not this tax cripple those interests and therefore be most impolitic and unstatesmanlike?

Fifth. Most of our populous counties are interested in the coal and iron trade (two interests inseparably connected) and therefore this tax would be most unpopular.

I might say that another objection to this tax is (although perhaps not a very legitimate one) that it would be next to impossible to collect and it would tend to insubordination. It certainly would tend to repudiation.

I am, very truly and respectfully yours,

F. W. Hughes

The United States now occupies third place in the list of coal exporting countries of the world, the coal exports of the United Kingdom for the calendar year 1912, having been 85,000,000 tons; those of Germany, 39,000,000; the United States, 26,500,000 (including bunker coal and shipments to Hawaii and Porto Rico); Austria-Hungary, 8,500,000, Belgium, 6,500,000; Japan, 3,500,000, and France, 2,250,000 tons.

Kentucky Mining Institute

The Kentucky Mining Institute will hold its midyear meeting on December 8, 1913, at Lexington, Ky.

The following program has been announced:

Meeting will be called to order at 1:30 P. M. Address of welcome, by Judge Henry S. Barker, President of State University. Response, by W. L. Moss, President of the Institute. The following papers will be read and discussed:

"The Clinkering of Mixed Coals Under High Temperatures," by R. D. Quickel, Fuel Agent of the Cincinnati Southern Railway.

"Problems Encountered in Mining Coals in the Western Coal Field of Kentucky," by Newell G. Alford, Assistant Engineer of the St. Bernard Mining Co., Earlington, Ky.

"The Use of Gasoline Motors in Coal Mines," by W. C. Whitcomb, General Manager of the Geo. D. Whitcomb Co., Rochelle, Ill.

"The Oil Fields of Northeastern Kentucky," by Dr. S. R. Collier, West Liberty, Ky.

"Safeguards in the Use of Electricity in Mines," by W. E. Freeman, State University of Kentucky.

"The Bearing of Coal Mining on Local History," by Otto A. Rothert, Louisville, Ky.

Address by Senator Joseph F. Bosworth, Middlesboro, Ky.: "The Importance of the Coming Session of the Legislature to the Mining Industry of the State."

There will be a smoker given by the mining society of the College of Mines and Metallurgy, at which the following topics have been suggested for discussion:

1. Mine Accidents: (*a*) What constitutes a "mine accident?" (*b*) When is a death a "fatal mine accident?" (*c*) What constitutes a "serious" mine accident? (*d*) What accidents should be reported for the Mine Inspector's records?

2. Shall there be a first-aid contest at the annual meeting? If so, when and where?

3. Miscellaneous.

Practical Talks on Coal Mining

For men who desire information on Coal Mining and related subjects presented in a simple manner

Mechanics of Mining

An Explanation of the Principles Underlying Calculations Relating to Engines, Pumps, and Other Machinery

By R. C. Strohm, M. E. (Continued from November)

THE fan that is shown in Fig. 38, is only one form, and a very simple form at that. There are a great many different types of centrifugal fans. In some the blades are straight and in others they are curved. The number of blades used varies according to the size and type of the fan, and their position may be either radial or inclined. A few of the more common forms of centrifugal fans will be described later.

The centrifugal fan is used very extensively in the ventilation of mines. It has just been shown that when a fan is rotated, a continuous current of air is set in motion. By directing this flow in proper channels, fresh air may be led into the mine workings or the foul air may be drawn out.

There are two different ways in which the ventilating fan may be arranged. The direction of the flow in the fan itself is in at the center openings and out at the circumference. Now, if the intake openings of the fan are connected by pipes or passages with the mine, the air that flows into the fan will come from the mine; that is, the foul air will be sucked out of the mine into the fan and then discharged into the surrounding atmosphere at the circumference of the fan. A fan that works on this principle is called an exhaust fan, because it draws or exhausts the air from the mine. The fresh air is then simply allowed to flow into the workings to take the place of the foul air that has been sucked out, and in this way a continuous circulation is established.

The other way of ventilating is to use a closed-running fan, and to lead the air discharged by the fan to the

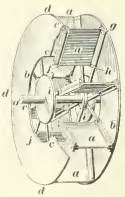


Fig. 38

mine workings. The fan draws in fresh air at the center and discharges it into the spiral casing, and this air is led by suitable pipes and passages to the desired places. The fresh air is thus forced down into the mine by the fan, and the foul air is driven out by the current of fresh air forced in. A fan that operates in this way is called a force fan, a blower fan, or a blow-down fan.

The casing that surrounds a fan and leads the air to it or from it is called the fan housing. An open-running fan has only enough housing to lead the air from the fan drift to the intake openings in the fan. But a closed-running fan has the circumference and sides of the fan wheel enclosed in a large spiral housing, which consists of two flat sides that fit at the sides of the fan wheel, and a plate bent into a spiral to enclose the circumference of the fan and fit against the flat sides. Each of the flat sides is cut at the edge to a shape to give the desired spiral, and a circular opening is made in each to register in size and position with the intake opening of the fan.

A sectional diagram showing the outline of the fan wheel and casing of a closed-running centrifugal fan is given in Fig. 39. The center of the fan-wheel shaft is at *a*, and the small circle *b c d* is the intake opening of the fan. The large circle *e f g* is the outer circumference of the fan, and the short, heavy radial lines between these two circles represent the blades, such as *b f*, *c e*, and *d g*.

The outline of the fan housing is a spiral *h i j* that gradually moves farther away from the center of the fan wheel. Thus, between the circumference of the fan and the outer casing there is a space that increases regularly in size from the point *h* to the point *j*. It is into this space that the air is discharged when the fan is running.

The direction in which the fan turns is indicated by the arrow *k* and under the effect of centrifugal force the air in each compartment of the fan is thrown outwards as indicated by the short radial arrows *l*. From the point *m* to the point *h* where the spiral begins, however, the fan housing has the form of an

arc of a circle and fits close to the circumference of the fan wheel over a distance at least equal to the space between the tips of two adjacent blades. The air in this space, therefore, is enclosed and cannot escape until the blade *c e* passes beyond the point *h* where the spiral casing begins to curve away from the fan. The air thrown out from the fan collects in the spiral space between the fan and housing and flows in the direction of the arrow *n* to the outlet *o*, called the chimney of the fan. From this point it may be led by suitable pipes or passages to the mine shaft or drift.

The reason for making the housing of a spiral outline is not hard to understand. From the point *h* to the point *p*, the housing must accommodate the air discharged from only one compartment of the fan. From *p* to *q*, however, another compartment is discharging, so that the space here must be able to accommodate the air from two compartments. From *q* to *i* another increase in the volume of air discharged takes place, and so on to the point where the air enters the chimney. As the width of the fan and housing remains the same the only way to give enough space for the gradually increasing amount of air is to increase the height of the space between the housing and the tips of the blades, the result being a spiral that gradually recedes from the circumference of the fan. In this way the air moves at the same speed in flowing along the casing toward the chimney. If the air passage were of the same size all around the fan, the air would have to travel faster

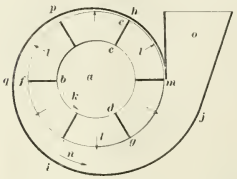


Fig. 39

as it neared the chimney, because of the increasing amount discharged.

The point *m* is known as the point of cut-off, because the air passing between the blades of the fan is there cut off from the chimney. The housing from *m* to *h* fits very close to the fan, so that air cannot pass between the two at this point; thus all the air discharged from the fan is compelled to flow around the spiral space in the direction of the arrow *n* to reach the chimney.

(To be Continued)

Mine Ventilation

Distribution of Air-Currents—Brattices and Stoppings—Different Materials and Methods of Construction

Written for The Colliery Engineer. *(Continued from November)*

STRICTLY speaking a brattice is a more or less temporary structure of a plank or heavy canvas erected along one side of a room or entry in order to conduct the air to the face, whereas a stopping is a substantial structure of some kind of masonry built to close off a breakthrough or an airway. In the United States the word stopping is rarely used, brattice being used to include all structures of the nature of those described.

Fig. 12 shows a brattice used in a gaseous mine to convey air to the face of an entry driven some distance beyond the last breakthrough. A row of posts is set parallel to the rib and at such a distance from it, say 2 to 3 feet, as not to interfere with the haulage. The distance between the posts depends upon the length of the planks used and may be 8, 10, 12, 14, or 16 feet. Ordinary undressed plank 1 inch thick, set so as to make as tight joints as possible are spiked to the posts. Commonly, no attempt is made to make these brattices air-tight, as they are temporary structures and are taken down as soon as the next breakthrough is driven. However, in very gaseous mines, strips of lath or of heavy cloth are nailed over the cracks between the planks, and to the top plank is also nailed heavy cloth to help fill the spaces between it and the roof. Wooden brattices for the purpose just described are not now in general use as brattice cloth is a cheaper and more easily handled substitute.

Brattice cloth comes packed in rolls of 50 or 100 linear yards and in standard widths of 36, 48, 54, 60, 72, 84, and 96 inches, although any desired width can be made to order. Waterproof brattice cloths are commonly made of jute and have either been treated with a filling of clay upon which is placed a coating of tar, or have been treated with a coat of stearin or some similar material. These cloths are all inflammable and are not extensively used. Untreated cotton duck is extensively employed for brattice making, but is decidedly inflammable (but not so much so as ordinary waterproof cloth) and is liable to rot. Non-inflammable brattice cloths are made of jute or cotton duck, the former being generally the lower in price for equal quality. These cloths are rendered non-inflammable by being surface coated with some incombustible material which is apt to render them stiff, heavy, and hard to handle. Those cloths in which the yarn before weaving has been treated with a fire-proofing solution, or those in which the finished cloth has been so treated, are usually to be preferred to those which have been surface coated. A good brattice cloth should be made of long fiber, hard twisted, closely woven yarn, treated to render it non-inflammable by some process other than surface coating. Hard yarn resists rot to quite an extent and does not readily become soggy. Such cloth does not readily unravel, which is an advantage as there will then be less loose open cloth that is unfit for use after cutting. The cloth in the piece or in single threads when exposed to the flame of a lamp

should show little or no flame but should char only.

Brattice cloth is commonly nailed at the top to a piece of scantling wedged or fastened across a breakthrough, or to a similar piece of scantling nailed to the top of the posts shown in Fig. 12. The nails are generally driven through the cloth 2, 4, or more inches from its upper edge so that a portion of the cloth may be roughly bunched or overlapped against the roof to lessen the leakage of air. It is not unusual, in making a brattice similar to that in Fig. 12, to allow the lower edge of the cloth to hang free with the exception of a nail in each post, but in some cases a second scantling is nailed to the posts at the floor and to this the brattice cloth is, in turn, nailed. Brattice cloth is generally ordered a little wider than the seam is thick in order to allow for overlap (as explained) at the top and the bottom. Where brattice cloth is used to stop breakthroughs, it is, naturally, cut to the width of the opening, but when used as in Fig. 12, one end is nailed to the first post and the bolt unrolled as the brattice is extended. In this way, cutting which is always objectionable and wasteful is avoided, and when the brattice is no longer needed, the nails may be removed and the cloth rerolled upon the rest of the bolt.

Fig. 12. Brattice

Brattice cloth may be fixed in place by staples or by wire or cut nails which are fitted through a small tin cap to give the head of the nail greater bearing upon the cloth so that it will not pull through. These caps or washers are about ¾ of an inch in diameter and are either flat or crimped and in some cases the outer edge is bent down and sharpened into small tooth-like projections to better grip and hold the cloth.

(To be Continued)

Electricity in Mines

Electrical Work — Electrical Power — Electrical Unit of Power — Relation Between Watts and Horsepower

By H. S. Webb, M. S. (Continued from November)

When an electric current flows from a higher to a lower potential, electrical energy is expended and work is done by the current. When a quantity of electricity flows against the resistance of a conductor, a certain amount of electrical energy is transformed into heat energy.

The actual amount of heat developed is an exact equivalent of the work done in overcoming the resistance of the conductor, and varies directly as that resistance. For example, take two wires, the resistance of one being twice that of the other, and send currents of equal strength through each. The amount of heat developed in the wire of higher resistance will be twice that developed in the wire of lower resistance.

The unit used to express the amount of mechanical work done is known as the foot-pound. The number of foot-pounds of work done in raising any weight through any height is found by multiplying the weight of the body lifted, expressed in pounds, by the vertical height, expressed in feet, through which it is raised; similarly, the practical unit of electrical work is the work done when a unit quantity of electricity, 1 coulomb, flows between potentials differing by 1 volt. The volt represents the pressure that forces the coulomb, representing quantity, through a circuit. The volt is analogous to the height to which the weight is lifted, and the coulomb to the weight of the object lifted, in the foot-pound analogy. The unit of electrical work is, therefore, the volt-coulomb, and is called the joule, after James Prescott Joule, an eminent English physicist, who did much to verify the law of conservation of energy, and lived from 1818 to 1889. 1 joule equals .7373 foot-pound.

To find the electrical work, in joules, expended in any circuit or conductor when the electromotive force acting on the circuit or conductor and the current strength are known, use the following rule:

Rule.—Multiply together the current, in amperes, the electromotive force, or drop, in volts, and the time, in seconds.

Example 1.—The total electromotive force of a circuit is 100 volts; the current flow is 10 amperes; how much electrical work is done in the circuit in 2 hours?

Solution.— 2 hours = 120 minutes = 7,200 seconds; by applying the rule, electrical work is $100 \times 10 \times 7{,}200 = 7{,}200{,}000$ joules. Ans.

Example 2.—The drop across a certain conductor, in the circuit mentioned in the preceding example, is 60 volts; how much electrical work does that conductor consume in 2 hours?

Solution.—Reducing the time to seconds and applying the rule, $60 \times 10 \times 7{,}200 = 4{,}320{,}000$ joules. Ans.

Electrical Power

It is necessary to make careful distinction betwen work and power. Power is the rate of doing work. In mechanics, the foot-pound is the unit of work; if 1 pound is lifted 1 foot, or 2 pounds are lifted ½ foot, 1 foot-pound of work is done. If 550 pounds are lifted 1 foot, or 1 pound is lifted 550 feet, 550 foot-pounds of work are done. It makes no difference whether the work is done in 1

second, 50 seconds, or 50 minutes, the amount of work done is the same, namely, 550 foot-pounds. Therefore, it may be said that work or amount of work is independent of time.

If, however, a certain amount of work must be done in a given time, it must be done at a certain rate, or a certain amount of power must be expended. For example, a man can easily raise 5,000 pounds 10 feet high, or perform 50,000 foot-pounds of work, if he is provided with suitable appliances for lifting the weight and is allowed a sufficient length of time to do it. If, however, the weight must be lifted through the 10 feet in 1 minute, he will not be able to do it; a man cannot do work at the rate of 50,000 foot-pounds per minute. A careful distinction must be made between the number of foot-pounds (work) and the number of foot-pounds per minute or second (power).

It has been estimated that a horse is capable of doing 33,000 foot-pounds of work per minute, or 550 foot-pounds per second, and the unit of power commonly used in mechanics and steam engineering is the horsepower.

The power, or rate of doing work, is equal to the total amount of work done divided by the time required to do the work. For example, if a weight of 20,000 pounds is lifted 16 feet, the amount of work done is 20,000 × 16 = 320,000 foot-pounds. But if this work is done in 10 seconds, work has been done at the rate of 320,000 ÷ 10 = 32,000 foot-pounds per second. As one horsepower = 550 foot-pounds per second, 32,000 foot-pounds per second is 32,000 ÷ 550 = 58.18 horsepower. In order to lift 20,000 pounds 16 feet in 10 seconds, it is necessary to have some source of power, such as a steam engine or an electric motor, that has a capacity of at least 58.18 horsepower. If 20 seconds were allowed for lifting the weight, 29.09 horsepower would be sufficient, because twice the length of time is allowed for doing the work. The longer the time allowed, the smaller will be the amount of power required to do a given amount of work, because the lower will be the rate at which work must be done.

Electrical Unit of Power.—The horsepower is not a convenient unit of power to use in electrical problems; it is more convenient to use a unit that can be defined in terms of the other electrical units. The electrical unit of work is the joule, and the electrical unit of power is therefore taken as 1 joule per second, and is called the watt. If, therefore, a current flowing in a circuit causes work to be done at the rate of 1 joule per second, the expenditure of power in the circuit is 1 watt. One watt is equal to .7373 foot-pound per second. To convert watts to foot-pounds per second, multiply the number of watts by .7373. To convert foot-pounds per second to watts, divide the number of foot-pounds per second by .7373.

To find the power, in watts, expended in any circuit when the current and the electromotive force used to force the current through the circuit are known, use the following rule:

Rule.—Multiply the current, in amperes, by the electromotive force, in volts.

Example.—An ammeter shows that the current flowing through an electric car heater is 13 amperes, and a voltmeter shows the drop across the heater to be 100 volts; how many watts are expended in the heater?

Solution.—Applying the rule,

watts = amperes × volts = 13 × 100 = 1,300. Ans.

Where the current and the resistance in a circuit are given, the watts expended may be readily calculated.

To find the power, in watts, to maintain the flow of a given current, in amperes, through a given resistance, in ohms, use the following rule:

Rule.—Multiply the current by itself and multiply this product by the resistance.

Example.—A certain electric heater has a resistance of 8 ohms when a current of 13 amperes flows through it; how much power, expressed in watts, is expended in the heater?

Solution.—By the rule, power = amperes × amperes × resistance = 13 × 13 × 8 = 1,352 watts. Ans.

If the electromotive force acting on a circuit and the resistance of the circuit are known, the power expended can be obtained.

To obtain the power, in watts, expended in a circuit of known resistance through which a current is set up by a known electromotive force, use the following rule:

Rule.—Multiply the electromotive force, in volts, by itself and divide the product by the resistance, expressed in ohms.

Example.—It requires 20 volts to force a given current through a resistance of 10 ohms; what is the power, in watts, expended?

Solution.—By applying the rule,

$$\text{power, in watts} = \frac{\text{volts} \times \text{volts}}{\text{ohms}} = \frac{20 \times 20}{10} = 40 \text{ watts.} \quad \text{Ans.}$$

Relation Between Watts and Horsepower.—It takes 746 watts to equal a horsepower. To convert watts into horsepower, use the following rule:

Rule I.—Divide the number of watts by 746.

To convert horsepower into watts, use the following rule:

Rule II.—Multiply the number of horsepower by 746.

Example 1.—Convert 15,000 watts into horsepower.

Solution.—According to rule I,

$$\text{horsepower} = \frac{\text{watts}}{746} = \frac{15{,}000}{746} = 20.1. \quad \text{Ans.}$$

Example 2.—Convert 20 horsepower into watts.

Solution.—According to rule II,

watts = horsepower × 746 = 20 × 746 = 14,920. Ans.

(To be Continued)

Water is never found pure in nature owing to the readiness with which it absorbs impurities from the soil and rocks.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Iowa Geological Survey.—We have received Volume 22 of the Iowa Geological Survey, which contains an account of the Geological Exploration of Iowa land; Geologic Reconnaissance in Iowa; Historical Sketch of Mining in Iowa; Systematic Geologic Surveying in Iowa, and an Annotated Bibliography of Iowa Geology and Mining. The report is by Charles Keys of the State Geological Survey. George F. Kay, State Geologist, Des Moines, Iowa.

Gold Dredging.—In his book on Gold Dredging, T. C. Earl has incorporated about all the important data connected with the industry, which has attained its greatest development in Australia, California, New Zealand, and Russia, and which is of growing importance in the United States, Alaska, South America, and elsewhere. The book is divided into 23 chapters, which deal with the following subjects: Gold, Ancient Workings, Modern Workings, Progress of Dredging, Capital Required, Dredging Ground, Reports, Prospecting, Salting, Bucket Dredge, Selection of Dredge, Erection of Bucket Dredge, Working of Bucket Dredges, Cost of Dredges, Dredge Crews, Working Costs, Pilfering of Gold, Gold-Saving Appliances, Percentage of Gold Recovered, Future of Gold Dredging, Resoiling, Pollution of Streams, and Fields for Dredging. There are 78 good illustrations and 7 maps.

The book is nicely gotten up and its contents are interesting reading. E. and F. N. Spon, Ltd., London, publishers. Price, 21 shillings, postpaid.

Mining Engineers' Examination and Report Book is the title of a little book, whose author is Charles Janin, Consulting Mining Engineer.

Editors of technical mining journals are frequently requested to recommend some book that will give information and show how to make reports on mineral lands, mines, and prospects. There are a number of forms extant for this purpose, but, so far as the writer knows, no good book on the subject, by which is meant information that may be used readily when composing a report. One of the signs which go to show the ability of the man making the report is the language he uses. If he fusses up the report by making use of the wrong terms, or if he uses a superabundance of inane geological terms, as did the man who called mud, an argillaceous, arenaceous, amorphous substance, intelligent men will be apt to class his report as mud, and doubt his ability as an engineer.

Mr. Janin has produced a book which will be found helpful to those accustomed to make mining reports, and invaluable to those who are unaccustomed to do so. The Mining and Scientific Press, of San Francisco, Calif., and the Mining Magazine, of London, England, are the publishers. Price, $2.50, postpaid.

Outline of Mineralogy.—Grenville A. J. Cole, Professor of Geology, in the Royal College of Science for Ireland, has written a book on the "Outlines of Mineralogy," for geological students. The subject of mineralogy is of fundamental interest to workers in many sciences, and being the natural history branch of chemistry, it is of the first importance to the miner, chemist, metallurgist, geologist, and agriculturist.

Many study mineralogy, although few can afford to specialize in it; therefore, when a mineralogy is written in a way which will be helpful to the many as a reference book, or as a textbook, it deserves recognition. Professor Cole's mineralogy is divided into two parts, one dealing with the character of minerals, the other with a description of minerals. There are 339 pages, including index, and 124 illustrations.

The explanation of crystals is exceedingly good, while his text contains many interesting features, such as the derivation of the names given some minerals, which makes interesting reading. Longmans, Green & Co., New York and London, are the publishers. Price, $1.60 net.

Maryland Geological Survey. Wm. Bullock Clark, State Geologist, has issued the fifth of a series of reports dealing with the systematic geology and paleontology of Maryland. The preceding volumes dealt with the Eocene, Miocene, Pliocene, and Pleistocene, and Lower Cretaceous deposits, while the present volumes treat of the upper and middle Devonian, the lower Devonian and their paleontology. The middle Devonian period has been described by C. S. Prosser, E. M. Kindle, and C. K. Swartz, and the upper Devonian by Messrs. Prosser and Swartz. The lower Devonian period was studied by Charles Schuchert, C. K. Swartz, T. P. Maynard, and R. B. Rowe.

A Notable Colliery Record

It is claimed that the Mansfield colliery, of the Bolsover Colliery Co., England, holds the world's record for a day (single shift), a week, a month, and a year. That this colliery is efficiently managed and worked by officials and workmen will be conceded when it is recalled that during the year 1910 there was not a single fatal accident. The colliery employs nearly 2,500 men and boys, of whom 1,950 work underground. As the result of a week's working of 5½ days, ending Tuesday, May 2, 1911, this colliery created a new record. In the week 25,068 long tons of coal were raised to the surface, working out to 4,557 tons per day. This, given an 8-hour winding day represents 570 tons an hour and 9½ tons per minute.

Correction

Our attention has been called to a mistake in the location of Turtle Mountain in the August, 1913, issue, page 13. The town of Frank is in the southwestern part of Alberta, and not in the southern part of Manitoba. The map has it right, but the text is wrong.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not neccessarily for publication.

The editors are not responsible for views expressed by correspondents.

Compound Interest by Logarithms

Editor The Colliery Engineer:

Sir:—In the communication on the above subject on page 179 of the October number, it will be evident that in the examples worked out the compound amount was found instead of the compound interest. Of course the latter is found by deducting the principal from the compound amount.

Florence, Colo. J. L. McNatt

Conveying Sand by Compressed Air

Editor The Colliery Engineer:

Sir:—In reply to your correspondent, L. Y., in your September issue, I would state that he can obtain information on conveying sand by compressed air from Mr. Paul, of the United States Reclamation Service, at Arrowrock, Idaho. At this point the United States Reclamation Service is constructing a dam. This conveying system is described in the *Mine and Quarry Magazine* for August, 1913.

Chicago, Ill. S. B. King

Tennessee Mining Laws

Chief Mine Inspector George E. Sylvester has sent the following letter to the mine operators of Tennessee, calling their attention to the laws recently passed:

Sir:—I enclose herewith amendment to the Mining Laws, passed at the extra session of the Legislature, September, 1913. Only two of the bills, namely, those pertaining to first-aid and mine rescue are, strictly speaking, mining bills. The bill relative to a 2-week pay day, although general in its character, would apply in some cases to mines and consequently has been included.

The bill requiring the keeping of first-aid supplies at mines goes into effect at once. Many of the mines have already complied with these requirements and I would suggest that those who have not done so give it immediate attention.

The American Red Cross and Johnson & Johnson both have on the market "Industrial Cabinets" in neat and convenient tin boxes, which sell for about $6 and meet the requirements of the law. Any suitable stretcher, whether purchased, or made at the mines, will serve the purpose.

This department is very much interested in the matter of seeing these regulations carried out in all cases, and this will be a subject on which the District Inspectors will report at each inspection.

Mine Rescue Bill. As will be seen there is nothing mandatory in this bill. It is recognized by mining men that few, if any, mines are entirely immune from the possibilities of a disastrous mine fire or an explosion.

The value of the oxygen apparatus is also recognized in such an emergency. The maintenance of such apparatus must be considered along the line of insurance; and the object of this bill is that the state shall assist and cooperate with the mines in this matter in order that an effective organization may be available in emergencies, and it is hoped that some of the larger mines or groups of mines will interest themselves in this matter.

The bill has the strong approval of this department, and I should be glad to take the subject up in detail with all interested parties in Tennessee.

Geo. E. Sylvester,
Chief Mine Inspector Tennessee
Nashville, Tenn.

A Few Pro's and Con's on Coke Manufacture

Editor The Colliery Engineer:

Sir:—We are hearing and reading more and more every day of the immense waste involved in the manufacture of coke by the beehive ovens, and the general superiority of the by-product process, and long columns of statistics prove beyond a doubt, that both theoretically and practically they are a vast improvement over the old type. But at the same time they are accompanied by some serious drawbacks, and, while they are gradually coming more and more into general use it is not amiss to consider one or two of these difficulties, and to realize fully the many little things that may so radically affect the product of the beehive type which we are apt to have with us for some time to come.

The first obstacle to be overcome in dealing with the by-product oven is to remove the strong prejudice which the foundry man holds against the by-product coke. While in many instances it is just as efficient as the beehive product, it contains a larger amount of water and is darker in color, both due to the fact that it has to be literally soaked in water when being extracted. The construction of the retorts being such that it is impossible to draw it with a minimum amount of water as in the old-style oven.

These two things have placed it in a bad light with the furnace man. He, of course objects to paying coke freight rates on water and, when comparing the black, damp, product with the bright, silvery, Connellsville coke to which he has long grown accustomed, the retort coke naturally suffers by the comparison, and is partially condemned before the work begins. Next come the difficulties of disposing of the illuminating gas. Usually the mines and ovens are located in a comparatively isolated district, and even if it were possible to pipe it to near-by towns or cities it would frequently be necessary to compete with natural gas companies, which would greatly reduce the profit on the gas.

These facts are not cited with any idea of condemning the by-product oven, and naturally these difficulties would be increased or decreased according to local conditions. But, after viewing the proposition from all points, it would appear that the people most capable of making an entire success of the by-product industry are the foundry men of the Middle West, who can easily obtain their choice of the West Virginia and Ohio coals at low freight rates, can utilize their own coke product, and, a great many of their plants being situated near large towns and cities, can readily dispose of the illuminating gas.

In the manufacture of coke, no matter what the process, the ultimate aim is to reduce to a minimum the percentages of sulphur, ash, and phosphorus. The accepted ideal coke for foundry purposes has the following analysis: Ash, 10 per cent.; sulphur, .70 per cent.; volatile matter, .75 per cent.; fixed carbon, 89.75 per cent.; moisture, .50 per cent. It is interesting to notice when dealing with coals, that at their best they barely come within this limit, and slight variations will materially increase the percentages of the undesirable elements. For instance, if for some reason it becomes necessary to crush the run-of-mine, or lump, coal, as is often the case during long periods of car shortage, the coke will immediately show a decided increase in ash and a proportionately small increase in sulphur, due to the fact that the larger the lump the greater the amount of binding material present, which, on analysis, will yield nearly all ash with a small portion of sulphur. Again, if charging from a bin not well filled, the heavier particles of pyrite and slate will become concentrated in a single charge and a part of the product will consequently make a much poorer showing than the remainder, which may have been charged later in the day when the bin has had an opportunity to fill up and the coal become more thoroughly mixed. It is also sometimes possible to trace a sudden rise in ash content directly to some portion of the mine where some miner has been carelessly shooting his coal, or possibly using dynamite, thus so pulverizing the rock that its presence only becomes visible in the final coke analysis. In this day of close competition these very little things often cause the making or losing of valuable contracts. Hence, the only systematic way of overcoming these many little difficulties which so frequently give rise to larger ones, is to keep a close tab on the coals from the various headings, occasionally testing their coking abilities separately, and to take into consideration the type of labor used in getting out the coal. Then it becomes a very interesting and comparatively simple problem to keep the coke up to a certain standard, and to trace all difficulties to their rightful origin.

F. S. Johnson, Chemist.
Davis Colliery Co.
Coalton, W. Va.

Pillar Drawing

Editor The Colliery Engineer:

Sir:—I would like to inquire if any of your readers have had experience in drawing pillars under the following conditions: The seam of coal is lignite and is from 6 to 12 feet thick. Just over the coal is a sandstone which is from 90 to 140 feet thick. The overburden is from 100 to 400 feet. The coal is united to a hard fireclay at the bottom, with no partings. The fireclay is 12 inches thick, there is then a stratum of soft fireclay 12 inches, then hard rock from 1 to 2 feet thick. The bottom heaves when the weight is too heavy on the pillars.

The coal is on the pitch, averaging about 3 per cent. The rooms are worked up the pitch and are driven 21 feet wide on 50-foot centers and are broken off the entry 10 feet wide for a distance of 25 feet, then widened. Cross-cuts are driven in rooms every 70 feet, leaving a pillar 60 by 29 feet. The rooms are usually 350 feet deep with 60 feet of barrier pillar from the end of the room to the air-course in the next pair of entries.

In places the sandstone will crumble and fall from 6 to 10 feet above the coal. There is always left from 2 to 4 feet of coal in the rooms to support the roof. A part of the mine has reached the boundary and will soon be ready to retreat, drawing the pillars. Any information based on experience or any advice relative to breaking this thick sandstone so that the greatest amount of coal may be taken out in drawing the pillars will be highly appreciated.

W. K. Anderson, M. E.
Colorado Springs, Colo.

Coal at Panama-Pacific Exposition

Mr. Charles E. Van Barneveld, Chief of the Department of Mines and Metallurgy of the Panama-Pacific International Exposition, to be held in San Francisco in 1915, is anxious to have the various coal mining fields of this country make a suitable display.

The following suggestions are given as what should constitute an exhibit for the coal industry:

Bituminous Coal.—(1) Samples of coal, large enough to show physical structure, say 10 pounds each. Photographs and charts to illustrate occurrence and distribution. For each kind of coal there should also be shown the full range of commercial sizes. Coking coals, however, should be shown in sizes used in ovens. If coal is washed, the natural and washed coal should be shown together. If coke is made from washed coal, samples of coke made from the natural coal should also be shown, for purposes of comparison. All samples should be accompanied by large cards giving locations, composition, calories, British thermal units, and fuel ratios.

(2) The distribution and production of coal from various districts should be brought out in a striking manner.

Attention should be called to the waste of coal and to the conditions responsible therefor, such as: Selective mining to eliminate undesirable portions of coal beds; competition and other market conditions; uses to

which the coal is put; and other reasons.

(3) Methods of mining should be illustrated by large-size plans and by models. The various important fields should construct topographic and geologic models accompanied by the necessary sections to thoroughly illustrate the occurrence and structure, and the special problems of their districts. Models should then be made to illustrate the methods of mining in vogue. If this work is done on a cooperative plan, the individual cost will be slight and the result will be a most instructive bituminous coal mining exhibit.

This offers an opportunity to emphasize the slogan of the coal miner of today: "Safety First." Special models, drawings, and photographs might well be prepared showing side by side the wrong and the right method, with emphasis placed on the evils resulting from the wrong method and remedial effects resulting from the right method.

(4) Surface handling of coal, sampling, and preparation for market should be emphasized by drawings, photographs, and models. There should be at least one working model of an up-to-date coal breaker and washer.

(5) Coke. The coking process should be thoroughly illustrated, with special reference in each case to the distinct use for which the coke is designed. This can best be done by models of coke ovens of various designs. The various mechanical operations required for transportation of coal to ovens, charging, and drawing off the coke, may be prominently featured.

The chemical control of ovens by continuous analysis should be illustrated so as to bring out the effect of time in the various operations.

The saving resulting from the use of by-product ovens should be brought out and contrasted with the losses incident to the use of the ordinary open, or beehive, oven. This should be supplemented with reasons why the beehive oven is still in use in spite of the undeniable losses.

The smoke problem, its effects and remedial efforts could be instructively featured.

The occurrence of gas in connection with coal and the manufacture of gas might also be illustrated.

Anthracite.—(1) An exhibit of coal to illustrate occurrence, cleavage, and other special features. The various trade sizes might be illustrated by pyramids of coal. One large dummy pyramid representing mine run, accompanied by pyramids of the various sizes representing the actual proportion of coal of each size. Statistical data regarding cost of production of the various sizes would be of interest.

(2) Methods of mining should be featured, as in the case of bituminous coal, to bring out the best practice from the standpoint of safety, efficiency, and conservation. The method of supporting excavations without timber and the substitution of steel and concrete for timber should be brought out. Special features should be shown, such as: The use of culm as a preventative of disintegration of pillars rather than as a support for the roof; how "creep" has entered into the problems of mining with increasing depth, how to prevent and how to remedy this difficulty.

The work of the "Mine Cave Commission" should be shown.

(3) Surface equipment for transportation, handling, washing, and preparing coal for the market should be shown by plans, photographs, and models. The retreatment of culm piles with demonstration of results obtained, would emphasize the progress of recent years.

(4) The sociological side of coal mining, the problems entering into transportation, storage, and marketing, together with statistics of production and consumption furnish topics for instructive exhibits.

卆 卆

Pure water is obtained by distillation; that is, it is converted into gaseous steam by heat and then cooled or condensed.

Specifications for Lubricating Oil*

Dr. P. H. Conradson, chemist, of Franklin, Pa., in discussing Mr. A. D. Smith's paper on "Purchase of Lubricating Oil by Specification," which appeared in the July, 1913, issue of The Colliery Engineer, says: "To prepare specifications for lubricating oils of practical value to the consumer, is a difficult and complex problem. I have specialized on lubricating oils for 20 years and I would hesitate today to draw up specifications that would answer for the practical purpose for which oils were intended. To prepare specifications that would be of practical value, the expert must be fully familiar with the machine to be lubricated, the service conditions, the manner of applying oil, and be familiar with the source of the oil and the processes of its manufacture.

It is also necessary to have well developed and satisfactory methods of testing the oils, which by no means is simple, as is clearly indicated by the number of tests the lubricating oils undergo in order to be fairly certain that they are suitable for the purpose intended. The oil experts in Europe have gone extensively into the subject of the proper method of testing lubricants, with the idea that when they have developed accurate and satisfactory methods, they will, in due course of time, take up the problem of preparing suitable specifications for lubricating oils for the various services.

In my paper presented before the Pittsburg Section of the American Chemical Society, on "Laboratory Tests of Lubricants and Interpretation of Analysis," there was given a tabulation of chemical tests that are necessary in testing lubricants for various purposes. They are as follows:

TABULATION OF CHEMICAL TESTS

Flash point.
Burning point.
Gravity.
Color.

*From November, 1912, Proceedings of the Engineer's Society of Western Pennsylvania.

Odor.
Purity.
Gasoline test, before and after flash.
Cloud test.
Cold test.
Viscosity.
Microscopic tests for carbonaceous matter in suspension.
Saponifiable fat.
Free fatty acids.
Petroleum acids.
Sulphuric acids.
Chemicals from inperfect refining.
Sulphur—lamp and in wick.
Maumene test.
Iodine test.
Evaporating tests, a given time at 200° to 300° F., to study percentage of volatile, and behavior of residues in 88 degrees gasoline tests and acidity.
Heat tests in air bath blowing air over the oil at 425° F., and 540° F. Examination of residue.
Emulsifying tests to determine adaptability of the oil, say in turbine service.
Tar and coke forming elements present before and after heat test.
Oxidation or gumming test.
Superheated steam tests.
Carbonizing tests in connection with air compressor (not cooled) automobile, gas engine lubrication.
Capilliarity or wick tests.

While in some cases it is not necessary to subject the oils to all these tests, however, they are of importance in studying the value of lubricating oils.

Specifications must not be cumbersome or complicated, and must be prepared in a way that will accomplish the object intended. The objection raised by manufacturers to even the simplest specification, is because it does not happen to coincide with their methods of manufacture. The commercial and financial side bearing on specifications that require unusual methods of manufacture, or which stipulate conditions which are not generally found among manufacturers, will necessarily increase the price of the lubricant. While specifications at first have been severely criticized by the manufacturers, they have stated that while they could meet the requirements, the product would cost very much more. If competition exists this matter will generally take care of itself after the manufacturer becomes familiar with the specified requirements.

It is mentioned in this connection that investigators abroad have demonstrated that all oils of equal viscosity have the same coefficients of friction, independent of the origin of the oils, method of refining, or nature of the oils. From these investigations one might deduce that prime lard oil or sperm oil would give the same coefficient of friction as straight mineral oil having the same viscosity at any given temperature, no matter whether the oil is of Pennsylvania, Texas, or Russian origin, etc. Now, if this be a fact, a great step forward has been made in the right direction.

In Mr. Smith's belief, cylinder oils, especially for superheated steam, should have a high flash and fire test, and he further believes that Pennsylvania oil is necessary for the production of good cylinder oils. I am an advocate of rather low flashing point in cylinder oils. I have come to this conclusion from many years of close study and observation of cylinder lubrication in actual service, as well as extensive laboratory investigations as to the behavior of cylinder oils in steam of various temperatures, from ordinary saturated steam temperatures up to the highest degree of superheat. I have found it advisable to have a certain amount of volatile constituents present in a properly compounded cylinder oil. In fact, a cylinder oil containing a certain amount of volatile compounds will mingle much better with the steam, and if we take into consideration the large area of the cylinders and steam chests and the small amount of oil used, it will readily be seen that the oil should be distributed with the steam in an atomized form, that is, lubricate the steam to get the best results.

To do this it is necessary that the cylinder oil should contain a certain amount of volatile constituents at steam temperatures used in service. This is only one point to illustrate how difficult it is to draw up specifications that would be of practical value to cover all cases.

Coming to the other classes of oils, such as automobile, machinery, turbine, gas engine, etc., it is evident that each kind of machine requires an entirely different oil to give the best and most economical service. Then again in preparing specifications, the treatment of the oil in actual service must be considered. In one case the oil may be fed to the journal, or cylinder, drop by drop, and never be used again, going off through the exhaust or otherwise. On the other hand, the oil may be reused for weeks or months, as in the steam turbine oil circulating system, where the oil is repeatedly exposed to heat, moisture, air, etc. To draw up specifications that will meet these conditions is a problem that requires study in the laboratory and in practical service.

The practice in Europe seems to be to take samples of oils and submit them to practical service tests; those that perform the service satisfactorily are analyzed to determine their constituents and then oils are purchased like the samples submitted. This practice is also followed extensively in this country.

Mr. Smith has pointed out that unless chemists and engineers who test oils come in closer contact and cooperation with the technical experts of the manufacturers of lubricating oils, they are at a disadvantage, and in the past it has been difficult to get any information from the refineries, either because they do not know or are unwilling to furnish it.

The American Society of Testing Materials has a committee on lubricants, composed of experts who represent both manufacturer and consumer; and it is hoped that this committee will, in time, be able to bring about closer professional cooperation, and develop specifications for lubricants.

Mr. J. Ablett, of Pittsburg, Pa., in discussing Mr. A. D. Smith's paper

on "Purchase of Lubricating Oil by Specification," said: "Mr. Smith concentrates his discussion entirely upon oils made from Pennsylvania Crude, and I would assume from the paper that it also applies to the method of manufacture. It fails to consider paraffin oils which belong to the same family as neutral oils, which Mr. Smith alluded to as best adapted for automobile use, etc.

I think, so far, there has not been a crude oil discovered that produces so satisfactory a cylinder oil as the Pennsylvania Crude. Therefore, it is clear that oils, like other materials, have different values.

We ought not to forget that the majority of paraffin oils made from western crudes have a market, just as do Pennsylvania oils; if they did not, the price of lubricating oil would be very high. In the paraffin family, engine oil particularly, is produced by distillation. It is put through various other processes and the wax is eliminated, as it is from the neutral oils. Some of these oils are finished with chemicals and others by filtration, and for some purposes paraffins are better suited than the neutral oils. They are heavier, have about the same flash, and as a rule, higher viscosity.

One great difficulty that oil men have had to contend with is that in many cases the proper oil is not applied. Some one who is naturally anxious to make a sale, tells the purchaser he must have an oil that conforms to certain tests, or conveys the idea that he must have a very viscous oil when a lighter bodied oil would do the work very much better, etc., so in many cases the wrong oil is introduced.

Cylinder oil is manufactured in a very different manner from engine oil. A good cylinder oil does not have a thin body; and if it had it would not be suitable for cylinder lubrication in large engines; but engine oils, or machine oils, for exterior lubrication are usually oils which will flow freely at from 25° to 30° F.

It is not always the price of an oil that denotes its value. A low-priced oil is better for some purposes than an oil of a higher price. An oil must be adapted to the work it has to perform. If the bearing is open, a heavy, viscous oil should be used which will not run off the bearing too quickly, and not a light-bodied oil which is suitable for running machinery at 2,500 or 3,000 revolutions per minute.

Mr. Conradson said there were some things about oils the users could not find out. People who spend years to learn how to produce certain oils that are suitable for machinery under peculiar conditions, could hardly be expected to publish their knowledge broadcast. If they did the consumers could not absorb it readily.

There are some things in the oil business that we do not know. The secret of putting oils together is a good deal like the man who could produce a better picture than the other artists, and when asked how he mixed his paints, replied, "I mix them with brains." It is only natural that the oil manufacturer should know more about his business than the man who has been educated along other lines. Referring to the subject of emulsion, which was brought up, oil that contains no impurities and which has been chemically treated, cannot produce an emulsion. When oil is mixed with a little water from the boiler in which boiler compounds are used, or should grease get in the oil, and it is kept circulating through the oiling system, with water, the oil will look like soap suds in a little while. When this condition exists it is blamed on the oil, but it is not the oil which causes the trouble.

The oil men need the assistance of the engineers and both should cooperate to overcome difficulties; for it is neither pleasant nor profitable to have to send a man out to adjust complaints, and find the oil is blamed for conditions for which it is not responsible.

Mr. Smith's paper was mostly on the subject of specifications, and if users adhere strictly to specifications, they are going to be misled, because there are oils which we can sell for half the price of others, which will often meet the specifications, but would not be at all suitable to the work required. Specifications, as a rule, are for the guidance of the manufacturer, to enable him to produce uniform products, and the laboratory is a necessary appendage to the refinery.

Oxidation of Coal

M. Mahler has recently made public the results of his experiments verifying certain facts which refer to most kinds of coals.

1. The continued loss of hydrogen under the action of air with gradually increasing temperatures.

2. The oxidization corresponding to the increase of volatile matter, and the decrease in calorific power, but only so far as a temperature in the neighborhood of 250°. Above this, oxidated coal commences to become poor in oxygen and to gain a little in calorific power without taking into consideration cinders and water.

3. The ulmic acid materials, which were formed, especially above 125°, disappear at the temperature of 250°.

Tread Mills

A mechanical horsepower is the supposed number of pounds a horse could raise 1 foot high from the ground in 1 minute. This is equivalent to raising 550 pounds 1 foot high in 1 second or 33,000 pounds 1 foot high in 1 minute, or to raising 1 pound 550 feet high in 1 second, or 1 pound 33,000 feet high in 1 minute. Before the days of the steam engine, wheels were turned by horses walking on tread mills, in fact, some farmers use them to this day for threshing purposes. Not long ago a bull was seen traveling on a tread mill that was doing no work, and on investigation the inquirer was informed that the bull had tossed the farmer, who took this method of getting even with said bull.

Answers to Examination Questions

Questions Asked at the Examination for Mine Foreman and Assistant Mine Foreman Held at Carbondale in the Anthracite Region of Pennsylvania, on June 23 and 24, 1913

Ques. 3.—Name the gases met with in coal mines, giving their symbols and their effect on the human system. State which are explosive and which are non-explosive.

Ans.—Oxygen, symbol O. It is not poisonous and has an exhilarating effect, stimulating the heart action. It is not explosive. Nitrogen, symbol N. It is not poisonous, but produces death by suffocation through excluding oxygen from the lungs. It is not explosive. Carbon dioxide, otherwise called carbonic acid, and, wrongfully, blackdamp, symbol CO_2. Its effect upon the system is practically the same as that of nitrogen. It is, also, non-explosive. Carbon monoxide, otherwise called carbonic oxide and, wrongfully, whitedamp, symbol CO. It is highly poisonous, even in very small quantities, being rapidly absorbed by the blood. It is very explosive. Methane, otherwise light carburetted hydrogen, marsh gas and, wrongfully, firedamp, symbol CH_4. Its effect upon the system is essentially the same as that of nitrogen. It is very explosive. Hydrogen sulphide, otherwise sulphuretted hydrogen and, wrongfully, stinkdamp, symbol H_2S. It is very poisonous, acting in a similar manner to CO. It is also explosive.

Ques. 4.—Describe fully the principles upon which natural ventilation depends.

Ans.—Strictly speaking, natural ventilation is a circulation of air throughout a mine which is produced by any natural agency, as by water dropping down a shaft, by wind blowing down a wind cowl, or by the difference in temperature between the mine and the outside thereof. Commonly, the first two means of producing a circulation of air are not considered, and natural ventilation is taken to mean that motion of the air through a mine which is produced by the difference in weight between two connecting air columns

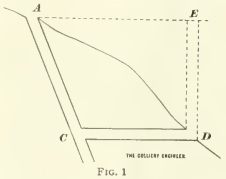


Fig. 1

due to the difference in their temperature. The weight of a cubic foot (the commonly used unit) of air varies inversely as the temperature, increasing as the temperature falls and decreasing as the temperature rises. Consequently the weight of the air in the shaft will vary according to the temperature, and if two shafts are connected, one filled with warm, light air, and the other with cold, heavy air, there will be a flowing of the air from the cold to the warm shaft. A shaft is not necessary to produce a circulation under such circumstances. In Fig. 1, a pitching seam is opened by a tunnel on the hillside, the seam being worked through to the crop on the top of the hill. In summer the mine temperature will be about 65° and that on the outside may be as high as 90°. In this case the air in $A\,C$ will be heavier than that in the imaginary column, $D\,E$, and will flow out of the mine through the opening D. In the winter, the mine temperature will be about 60°, and that of the outside air may be as low as 10°. In this case, the air column $E\,D$ will be heavier than $A\,C$, and the air will flow into the mine through D. Thus, the direction of flow of the air is from the point of low temperature (high pressure or weight) toward that of high temperature (low pressure or weight), and its velocity will depend upon the difference in these temperatures.

Ques. 5.—A, B, and C are injured in a mine. The injury to A causes bright red blood to flow in spurts. The injury to B causes purple or dark colored blood to flow, not in spurts. The injury to C causes blood to ooze from the injured parts. State how you would treat each case and distinguish the nature of the injury.

Ans.—The injury to A is a severed artery, to B a severed vein or veins, and to C, a breaking of the capillaries. The first two forms of injury are caused by cuts of varying depth; the last accompanies almost all kinds of wounds, particularly those bruises or mashings of the body caused by falling weights of any kind. Neglecting any disturbing causes, such as unconsciousness, broken bones, etc., the following treatment is recommended: In all cases have the person lie down, usually on his back, and if the wound is in an arm or leg, elevate the limb; then cut away the clothing so that the wound may be exposed and examined. In case of bleeding from an artery, cover the fingers or thumb with several thicknesses of sterilized gauze and press directly on the wound in order to stop bleed-

ing temporarily. If the part near the wound is badly crushed, pressure must not be applied to it, but higher up where the parts have not been harmed. Then apply pressure a short distance above, between the wound and the heart, by means of a tourniquet made of any available material. If this does not stop bleeding, pressure must be applied to the artery direct by crowding a wad or compress of gauze into the wound itself; this latter to be used in addition to and at the same time as the tourniquet, if the latter alone is not sufficient. After noticing that all the bandages are secure, place the patient in a stretcher and transport him to the surface. It is, of course, necessary that, as soon as the injured man has been found, some one be sent to the nearest underground telephone, to be sure that the doctor is at the mine as soon as the patient reaches the surface.

Bleeding from the veins may generally be stopped by placing a pad of gauze over the wound and binding it on with moderate pressure. In severe cases the treatment is not unlike that for hemorrhage from an artery, in that the patient should be made to lie down with the injured limb elevated and all tight clothing, etc., removed. After covering the hand with several thicknesses of sterilized gauze, press the fingers into the wound or fill it with gauze and press tightly.

In case of bleeding from the capillaries, a pad of gauze tightly bound over the wound is commonly sufficient. Ordinarily, no treatment at all is necessary, as exposure to the air for a few moments or bathing the part in cold water will stop the bleeding.

The methods here given are merely an outline of the general course to be followed; the actual procedure will naturally depend on the location of the injury, the supplies available, etc.

Ques. 6.—Under what conditions in a mine does the Anthracite Mine Law require the mine foreman to withdraw the men under his charge?

Ans.—By general rule No. 8, the foreman is obliged to order the men from the entire mine or from a dangerous part thereof when noxious gases or "any cause whatever" render the workings unsafe. Aside from outbursts of methane, among other causes that would render the mine or parts of it unsafe and thus necessitate the withdrawal of the men, would be a mine fire, the possibility of an inrush of water from old or adjacent workings, a stoppage of the fan, a dangerous squeeze, etc. Under these circumstances, the only persons allowed in the mines are those actually engaged in removing the danger. All other employes must keep out "until the said mine or said part thereof is examined by a competent person and reported by him to be safe."

Ques. 7.—State in detail what should be done to reduce the number of accidents due to falls of rock and coal and movement of mine cars.

Ans.—This question is answered in detail in The Colliery Engineer for July, 1913. See Ques. 3, 4, and 5.

Ques. 8.—What is the relative strength of two props, diameter equal, one 6 feet long and the other 12 feet long?

Ans.—As props generally fail by bending before they crush, the strengths of the two posts will be inversely proportional to the squares of their respective lengths or as $(12)^2 : (6)^2 = 144 : 36 = 4 : 1$. That is, the post 6 feet long will sustain four times the load of the post 12 feet long. If the posts were of sufficient diameter to resist bending under vertical pressure, they would sustain the same loads regardless of their lengths, provided their diameters were the same.

Ques. 9.—What practical methods would you adopt and enforce in and about mines to reduce the liability of accidents from the use of electricity?

Ans.—All electrical apparatus should be installed by a competent electrical engineer upon the lines laid down by the United States Bureau of Mines, and following the laws enacted in 1911 for the bituminous mining regions of Pennsylvania. If this is done the foreman should see to it that all safety devices used in connection with the electrical equipment are frequently tested and kept in good working order and for this purpose a competent electrician should be employed. In addition, all employes should be warned as to the dangers involved through coming in contact with live wires, both verbally and by notices posted throughout the mine, and no one should be allowed to operate any electrically driven machinery who has not been thoroughly instructed in its use.

Ques. 10.—A heading is 8 feet wide at the top and 12 feet wide at the bottom, and 8 feet high. What velocity per minute should the anemometer attain to conform with a quantity of 32,000 cubic feet of air per minute if there are 150 persons employed in this heading? How many splits of air should there be to conform with the mine law?

Ans.—The number of persons employed in the heading has nothing to do with the velocity of the air. The area of the heading is $\frac{8+12}{2} \times 8 = 80$ square feet. The velocity is equal to the quantity ÷ the area = 32,000 ÷ 80 = 400 feet per minute. As the law requires that not more than 75 persons shall be employed in any one split, there should be, in this case, 150 ÷ 75 = 2 splits.

Ques. 11.—What are the duties of a mine foreman and his assistants relative to the care and treatment of the injured? What act applies?

Ans.—The act approved May 29, 1910, applies in this case. Under this act all anthracite mines must have built at some convenient point underground, what is known as a medical room, which shall not be less than 8 feet by 12 feet in size. This room shall be provided with a *sufficient* quantity of linseed or olive oil, bandages, linen, splints, and woolen and waterproof blankets, and shall be *sufficiently* furnished, lighted, clean and ventilated so that it will serve for emergency or first-aid

treatment of the injured. The furnishings shall be sufficient for two or more persons in a reclining or sitting position. The foreman or assistants shall visit the scene of every accident as soon as notified, and shall see that the injured is carefully wrapped in woolen blankets and removed to the "medical room," to be there treated in such a way (depending upon the nature of the injury) as will add to the comfort and care of the patient. After being treated, the injured person shall be carefully wrapped up, sent to the surface and taken home or to the mine hospital. In event that the accident involves injury to the limbs or causes loss of blood, bandages, splints, or linen shall be applied where necessary to prevent loss of blood and to relieve pain. In all cases the patient must be removed to the surface without delay. The foreman must keep a record book showing the required articles on hand, name of persons injured, nature of injury, treatment, and by whom treated at the time of the accident.

Ques. 12.—What is the law governing the construction of passageways for persons in mines where the roads are also used for the transportation of coal and other material? State fully.

Ans.—According to general rule 43, "Every passageway used by persons in any mine and also used for transportation of coal or other material, shall be made of sufficient width to permit persons to pass moving cars with safety, but if found impracticable to make any passageway of sufficient width, then holes of ample dimensions and not more than 150 feet apart, shall be made on one side of said passageway. The said passageway and safety holes shall be kept free from obstructions and shall be well drained; the roof and sides of the same shall be made secure." In addition, general rule 47 relating to running cars on gravity roads by means of sprags provides that "a space of not less than 2 feet shall be made on one or both sides of the track, and said space or passageway shall always be kept free from obstructions." Finally, general rule 49 provides that "safety holes shall be made at the bottom of all slopes and planes and be kept free from obstruction to enable the footman to escape readily in case of danger."

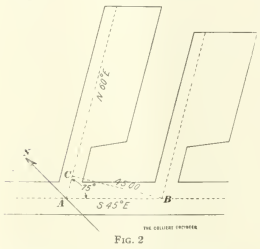


Fig. 2

Ques. 13.—A main heading 12 feet wide is driven N 60° E; a counter heading is driven from the main heading on a course of S 45° E. Chambers are opened on the counter heading and are driven parallel with the main heading. What is the distance between the center lines of the chambers when the width of the chamber and pillar is 45 feet?

Ans.—The question is, perhaps intentionally, misleading as asked. Since the chambers are parallel to one another, it is apparent that their center lines are 45 feet apart measured at right angles to the direction of driving. It is probable that the question should ask for the distance between centers of chambers measured along the line of the counter gangway.

The layout is shown in Fig. 2, from which it will be noticed that the width of the heading is not concerned in the problem. The direction of the chambers is N 60° E, the same as that of the main heading. As the counter heading is driven S 45° E, the angle between its center line and that of the chambers is (90° − 45°) + (90° − 60°) = 45° + 30° = 75°. We have, then to solve the right-angle triangle $A\,B\,C$, in which the side $B\,C$ is the distance between the center lines of the rooms (measured at right angles to their direction) or 45 feet, and the angle opposite, A, is 75 degrees. The distance between the centers of the chambers, measured along the counter heading, is the hypotenuse of this triangle or the distance $A\,B$. From trigonometry, the hypotenuse = the side opposite the angle ÷ by the sine of the angle = 45 ÷ sine 75° = 45 ÷ .96593 = 46.58 feet.

Ques. 14.—When working places are approaching places where there is likely to be an accumulation of explosive gases or dangerous accumulation of water, what precautions must be taken according to law in each case? State fully.

Ans.—When approaching workings liable to contain dangerous amounts of explosive gases, "no light or fire other than a locked safety lamp shall be allowed or used." These safety lamps are the property of the operator and must be examined by a competent person appointed for the purpose immediately before they are taken into the mine to be certain that they are clean, safe, and securely locked. Lamps must not be used which do not fulfil these conditions, although the mine foreman may give permission to use the lamps unlocked. Unless properly authorized, no one shall have any device for unlocking these lamps in mines where their use is required, nor shall any one carry into such a mine a match or other apparatus for striking a light. Where locked lamps are required, no shot shall be fired without the permission of the foreman or his assistants, and not then until the place itself and the adjoining places have been examined for gas to be sure that firing is not dangerous.

If a place is approaching workings which may contain a dangerous accumulation of water, its width shall not be greater than 12 feet, and "there shall be constantly kept at a distance of not less than 20 feet in advance, at least one bore hole near the center of the working and sufficient flank bore holes on each side." The object of these bore holes is to tap any dangerous body of water before the workings are driven into it.

Ques. 15.—With 1 inch of water gauge a velocity of 450 feet of air per minute is found in an airway 7 feet 6 inches by 12 feet. What is the total quantity of air passing, and what would be the velocity and total quantity if the water gauge was increased to 2 inches?

Ans.—The quantity of air passing is equal to the area of the airway multiplied by the velocity of the air in feet per minute or, $(12 \times 7.5) \times 450 = 90 \times 450 = 40{,}500$ cubic feet per minute under 1 inch of water gauge.

The quantity of air passing will be increased in the ratio of the square roots of the respective water gauge readings or, $40{,}500 : x = \sqrt{1} : \sqrt{2}$, or $40{,}500 : x = 1 : 1.414$; from which $x = 40{,}500 \times 1.414 = 57{,}267$ cubic feet of air per minute under 2 inches of water gauge.

The velocity of the air passing will be equal to the quantity in cubic feet per minute divided by the area of the airway in square feet, or $57{,}267 \div 90 = 636.3$ feet per minute velocity when the water gauge is 2 inches. This result may also be obtained from the relation that the velocities are proportional to the square roots of the respective water gauge readings or, $450 : x = \sqrt{1} : \sqrt{2}$, or $450 : x = 1 : 1.414$, whence $x = 450 \times 1.414 = 636.3$ feet per minute, as before.

Ques. 16.—At the bottom of a shaft 350 feet deep, a rock tunnel 7 feet high and 12 feet wide is driven. A dam is built in this tunnel and the shaft is allowed to fill with water. What is the pressure per square inch and the total pressure in pounds on the dam?

Ans.—The height of the column of water producing pressure at the bottom of the dam is 350 feet, and the height of that producing the pressure on the top of the dam is $350 - 7 = 343$ feet. Hence the height of column producing average pressure on the dam is $(350 + 343) \div 2 = 346.5$ feet. The weight of a column of water 1 inch square and 1 foot high is commonly taken as .434 pound. Hence the weight of a column of water 346.5 feet in height and 1 inch square, which is the same thing as the pressure per square inch, is $346.5 \times .434 = 150.38$ pounds.

The total pressure upon the dam may most quickly be found by multiplying its area in square feet by its average depth below the surface by the weight of a cubic foot of water or, $(7 \times 12) \times 346.5 \times 62.5 = 1{,}819{,}125$ pounds $= 909.56$ tons. The same result may be obtained by multiplying the area of the dam in square inches $(7 \times 12 \times 144 = 12{,}096)$ by the pressure per square inch, 150.38 pounds, as previously determined.

Ques. 17.—Describe the principle and construction of the Davy safety lamp and state under what conditions does it become unsafe.

Ans.—The Davy lamp consists essentially of a metal receptacle for oil, provided with the necessary wick, etc., for burning the same and producing a light. The wick is surrounded by a cylinder of gauze 5½ inches high and 1½ inches in diameter and closed at the top. The gauze is what is known as "28 mesh," that is, it is made of two sets of 28 parallel wires per inch crossing each other at right angles and thus making $28 \times 28 = 784$ openings in each square inch of its surface. This gauze is surmounted by a gauze cap, completely enclosing the flame of the lamp, and increasing the height of the chimney to 6 inches. This cap is double at the top where the gauze is most liable to burn through, or to become hot and pass the flame. The lamp is sometimes provided with a sheet-metal shield or bonnet which serves to prevent the flame being blown through the gauze when it is exposed to air-currents of high velocity or when it is swung violently in air-currents of ordinary velocity. The safety of the lamp depends upon, or is brought about by, the fact that the flame of a mixture of methane and air burning within the lamp is so cooled by passing through the meshes of the gauze that its temperature is reduced below the point at which the same mixture outside the lamp will ignite.

The safety lamp is dangerous when there is a hole in the gauze that will permit the passage of flame to the outside, or when the gauze is dirty, so that any particular spot may be overheated, or when the velocity of the air is so great that the flame is blown through the gauze, or (generally) when in the hands of an inexperienced person. The unbonneted Davy lamp is not safe where the velocity of the air exceeds 360 feet per minute. The velocity with which the air strikes a lamp carried against it is increased by the amount equal to the rate at which the fireboss travels. If he walks at the rate of, say, 4 miles an hour or 352 feet a minute (on the gangways he will usually have to move faster than this to make his rounds on time) he will create by his own motion (and in still air) a velocity practically the same as that at which the unbonneted Davy is considered unsafe.

Ques. 18.—If the safety lamp gives no indication of the presence of explosive gas, is this fact proof that the atmosphere is safe to enter? Name six essential features of a good safety lamp for general work.

Ans.—While not absolute proof, the failure of the lamp to indicate the presence of explosive gas is usually sufficient indication that the place is safe to enter, provided, of course, the fireboss uses other available evidence. The presence of CO_2 is indicated by the going out of the lamp. If the flame is instantly extinguished there is probably a sufficient amount of this gas to render it unsafe to enter; if the flame goes out slowly, the place may be entered if absolutely necessary, as it is well recognized that a man may work for a comparatively long time in an atmosphere so charged with CO_2 that a lamp will not burn.

The other explosive mine gases which naturally show a cap on the flame are both of them fatal in a few minutes, or seconds even, when present in such small amounts that they may be detected only by chemical analysis. Fortunately they are both very rare, and one of them, hydrogen sulphide (H_2S) may be detected by its characteristic un-

pleasant odor long before dangerous proportions of it are present in the air. The other, carbon monoxide (*CO*), is the most dangerous of mine gases. The statement made that this gas may be detected by the fire-boss in the ordinary course of his rounds and with an ordinary safety lamp does not appear to be founded upon observed facts. The presence of this gas has rarely to be expected, and when present, it is not concentrated near the roof like methane but is thoroughly mixed with, and disseminated through the air. For this reason, and because an amount of this gas so small that it may be detected only by chemical analysis produces speedy unconsciousness and death, long before the fireboss has reached the place where he is accustomed to test for methane, he has been overcome by the monoxide and, no help being at hand, must die. The statement that "no man ever saw the flame cap of carbon monoxide burning within a safety lamp and lived to tell the tale," must remain undisputed until better evidence than is now available is brought forward. Fortunately, *CO*, is one of the rarest of gases and is to be looked for only as a constituent of afterdamp, of the gases given off by gob fires, and of the burning of certain explosives.

Hence it may be concluded that under all ordinary conditions, a place is perfectly safe to enter if the flame of the safety lamp does not show a cap. Following an explosion or when approaching a gob fire, this may not be the case.

The essential features of a good safety lamp for general work are (1) maximum illumination combined with lightness of weight; (2) a construction such that the flame will not pass through the gauze when the lamp is exposed to air-currents of high velocity; (3) a method of locking so that it cannot be opened by unauthorized persons or in dangerous places; (4) simplicity of construction with consequent lessened liability of getting out of order; (5) a means of relighting the lamp in the mines without having to unlock it; (6) sensitiveness to gas so that small amounts may be safely and readily detected.

Ques. 19.—The anemometer makes 3.25 revolutions in 1 minute. The section of the airway is 6.25 feet high and 8.5 feet wide. What quantity of air is circulating, allowing 3 per cent. loss for resistance in the anemometer?

Ans.—The anemometer indicates that the air is traveling at the rate of $3.25 \times 100 = 325$ feet a minute. Owing to resistance, however, this velocity is but $1.00 - .03 = .97$ of the true speed, which is $325 \div .97 = 335$ feet (about) per minute. The area of the airway is $6.25 \times 8.5 = 53.125$ square feet. The quantity is equal to the area multiplied by the velocity, or $53.125 \times 335 = 17.797$ (very nearly) cubic feet a minute.

Ques. 20.—In a gaseous mine in which 500 persons are employed, an accident happens to the fan, causing it to stop running shortly after commencing work in the morning. What steps would you take as mine foreman to insure the safety of the workmen? Describe fully.

Ans.—Ring the alarm bells, if there are any, in order to warn the men to leave the mine. If there are no bells, send messengers to the various working places for this purpose. In the meanwhile put out all open lights and only use such safety lamps as are absolutely necessary. Cut off any electric currents passing into the interior workings. Get the men to the foot of the hoisting shaft and raise them to the surface as soon as possible even if more than the legal number are crowded on the cages. Keep discipline while loading the men on the cages, even if force must be used for that purpose.

Shooting Off the Solid

A special feature of the United States Geological Survey's report on coal in 1911 and 1912 is a statement to the extent to which "shooting off solid" is practiced in the bituminous coal mines of the several states, from which some instructive conclusions may be drawn. The more frequently that practice is condemned by writers and speakers and the more widely it is prohibited by law and by company rules, the safer it will be for the miners and the better for the industry.

Method of Tamping for Greater Safety in Blasting

By G. Volf

The chief danger from explosions in mines is now known to be caused by firedamp or coal dust, and special efforts are in progress to minimize risk in blasting, and to restrict the area of explosions. Research work in this direction is the latest outcome of scientific mining. The difficulty is met by forming explosion-proof areas, constant damping of the coal-dust in a mine, and its removal as far as possible.

Experiments have lately been made to reduce the danger of an explosion spreading through a level by the use of external tamping of sand or powdered rock. A cap of non-explosive dust or sand is placed over and in front of the mouth of the bore hole, the object being to stifle the flame of the hot gases generated by the explosion. The dust is said to act partly by absorbing heat of gases, partly by converting it into work by adiabatic expansion. Experiments have been made to determine the quantity of external tamping required to quench the flame of a given blasting charge. The temperature of ignition of mine gas is given at 675° C. (1,247° F.); the temperature of the tamping must therefore not be allowed to exceed 600° C. (1,112° F.). The amount required varies from 4½ to 15½ pounds (2 to 7 kilograms) according to the kind of explosive used. This method has been worked with success in the Ostrau-Karwin coal mines, and should always be adopted when blasting in critical places. Sand or powdered rock should be freely laid over the floor, and, if the blasting is in the roof or "breast face," the sand should be piled on planks under the bore hole.

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

46. Suppose it requires 1 inch of water gauge to circulate 30,000 cubic feet of air per minute, and it is required to reduce this quantity to 25,000 cubic feet per minute by fixing a regulator. Find the area necessary for a regulator.

47. What is the breaking strain of an oak beam, 6 feet long between the supports, 10 inches deep and 5 inches wide, with the load evenly distributed and both ends fixed. How much stronger is the beam than one of the same quality 7 feet between supports, 9 inches deep, and 6 inches wide, fixed in the same way, but with the weight in the center?

48. What size and description of pumps and equipment would you adopt to raise 400 gallons of water per minute from a depth of 1,000 feet?

49. Explain with sketches how you would deepen an upcast shaft without interfering with the hoisting of the coal, the work of sinking to proceed continuously.

Answers for Which Prizes Have Been Awarded

Ques. 39.—A high-tension cable is to be placed in a shaft 800 feet deep. How would you hang the cable and support it in the shaft, assuming it could not be made self-supporting? Illustrate by sketches.

Ans.—To properly install such a cable, it should first be taken to the shaft bottom, uncoiled, and extended along the landing. A galvanized steel-wire cable, known as a "messenger," of a diameter suitable to the size of the conducting cable, which, for the tension and depth, should be not less than 5/8 inch, is then laid along the cable and securely fastened to it by means of wiped joints at intervals not exceeding 6 to 8 feet.

The lengths or spread of the joints should not be less than 8 inches. At intervals of about 50 feet or at such intervals as may best conform to the spacing of the buntons, the messenger should be bent back or reversed upon itself, forming a loop about 2 feet long, extending toward the top of the shaft when the cable is in position, as shown in Fig. 2. The loop should be not less than 2 feet in length, and clamped at the bottom of the reverse, and the messenger should be wipe-jointed to the cable above and below the loop.

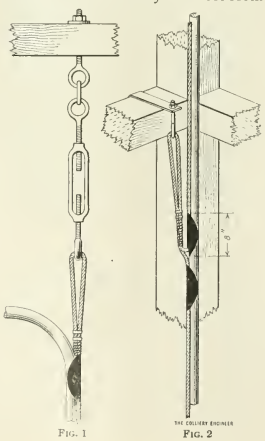


Fig. 1

Fig. 2

In the loop at the top part of the cable, where it is to be attached to the shaft bunton near the surface, the eyelet of a turnbuckle should be inserted. The messenger being securely fastened to the cable, a chain can be attached to the top loop of the messenger and the cable drawn up the compartment in which it is to be placed. The messenger is secured to a bunton near the surface by means of an eyebolt and insulated turnbuckle, as shown in Fig. 1. The cable being thus held in position, the workmen can descend the cage compartment, place a suitable staging across the cable compartment at the position of the loops, pass chains through the loops and fasten them to eyebolts passed through holes in plates which are fastened to buntons, as shown in Fig. 2.

This method would hold the cable in position near one corner of the compartment without permitting it to come into contact with anything

that would wear the armor by abrasion, or cause a ground in case of contact, and also prevent as far as possible, the acidulated waters of the

form is that if the cager is in a hurry he forgets to throw the skips, which might cause a wreck. The advantage is a great one, as there is

proposed to install an auxiliary motor of the same power. Show by sketches how you could connect the motors so that a change could be

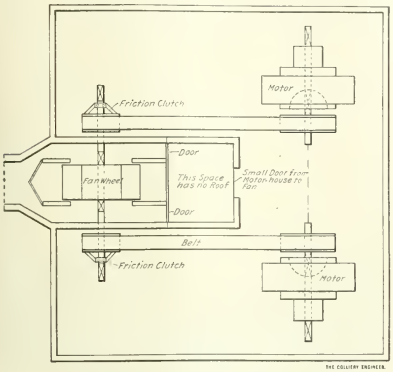


Fig. 3

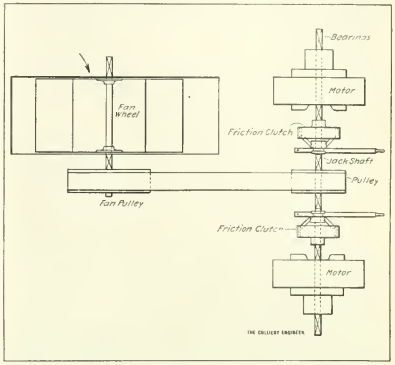


Fig. 4

shaft from coming into contact with the cable or messenger.

Jerome, Pa. I. C. Parfitt

Second Prize, R. Z. Virgin, Colliers, W. Va.

Ques. 40.—Show by sketches which, in your opinion, is the most reliable method for holding cars in cages. Mention various appliances in use, pointing out the advantages and disadvantages of each.

Ans.—Fig. 5 shows a form of car holder for cages, which is reliable. This form has been in operation for about 25 years. It is known as the "skips." The skips *A* are blocks of iron that fit over the rails just between the car wheels and are operated by the bar *B*. This bar is pivoted on the pin *P*. From this bar two arms *C* are pivoted, which fasten on the skips.

By moving the bar to the right, as shown in the dotted lines, the skips are moved off the rails, allowing the car to be pushed on the cage. The cager then throws the bar to the left and the car is held in place by the skips. Fig. 5 (*b*) shows how the car is held in place.

The only disadvantage of this no delay in changing cars and holding them in place.

Eddie Jones

Rockvale, Colo.

Second Prize, R. Z. Virgin, Colliers, W. Va.

Ques. 42.—A ventilating fan is driven by an electric motor. It is

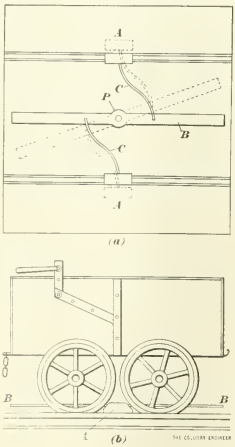


Fig. 5

made from one motor to the other without stopping the fan.

Fig. 3 shows a large double-inlet reversible fan. The shaft is in one piece and the pulleys are mounted on large brass bushings; both pulleys run loose on the shaft. The fan can be running at full speed, the other motor can be started, and when up to speed the clutch can be thrown in, and the other motor cut out.

I would not advise making the shaft in three pieces and clutching it, as the fan is much heavier than the pulley and piece of shaft, and the bearings wear down faster; consequently the shaft gets out of line very quickly and the clutch will not give satisfaction.

In Fig. 4 I show a single-inlet fan driven by two motors connected by clutches to a jack-shaft which carries the driving pulley. Belt or chain may be used with this arrangement, and will give very good satisfaction.

The writer has installed and operated fans connected as illustrated, and they gave excellent results.

H. T. Booker

Monongahela, Pa.

Second Prize, I. C. Parfitt, Jerome, Pa.

Ques. 41.—A pump whose water end is 10 inches in diameter has to work 19 hours a day. What size pump will have to be provided to replace this to do the same work in 8 hours, with twice the steam pressure, the length of stroke, etc., remaining the same?

Ans.—The capacity of a direct-acting pump is directly proportional to the area of the water piston and speed of travel of that piston. That is: $C = A \times L \times N$,

where C = capacity, in cubic feet per minute;

A = area of water piston, in square feet;

N = number of working strokes per minute.

So in the present problem, where the length of stroke and speed of piston travel are the same in both cases, the capacities of the two pumps will vary directly as the areas of the two water pistons.

If the first pump pumps a given quantity of water in 19 hours, and the second delivers the same quantity in 8 hours, the capacity of the second must be $\frac{19}{8}$ as great as the first. If then, the capacities vary directly as the areas of the two pistons, the areas of the water piston of the second pump will be $\frac{19}{8}$ as great as that of the first pump or,

$A_2 = \frac{19}{8} \times .7854 \times 10^2 = 185.6$ square inches

and the diameter corresponding to this is $15\frac{3}{16}$ inches, say 15 inches.

The steam pressures adopted will affect only the steam ends of the pumps. The indicated work of the steam cylinder will be given by the formula:

$$W = P \times L \times A \times N$$

Here W = foot-pounds per minute;

P = steam pressure, in pounds per square inch;

A = area of steam piston, in square inches;

N = working strokes per minute.

From this formula, it is evident that for a given length of stroke and a fixed speed, the work done will be proportional to the steam pressure and piston area. If then, the second pump must do $\frac{19}{8}$ as much work per minute as the first, its piston area must be $\frac{19}{8}$ as large as that of the first, the steam pressures being the same. But since the steam pressure in the second case is twice that used in the first, the area of the second piston need only be $\frac{1}{2}$ of $\frac{19}{8}$ or $\frac{19}{16}$ times the area of the first.

Frank H. Wagner

Wilkes-Barre, Pa.

Second Prize, P. M. Weigle, Hooversville, Pa.

OBITUARY

Col. Louis W. Powell

We regret to learn of the death of Col. Louis W. Powell, one of the best known mining engineers in the country. Colonel Powell was born in Wythville, Va., and after graduating from Washington and Lee University, commenced his career on the Gogebic range. When the United States Steel Corporation was organized he became vice-president of the Oliver Iron Mining Co. He resigned this position to go to Bisbee, Ariz., to take charge of the Calumet and Arizona and Superior and Pittsburg properties. He had charge also of the properties which were merged into the Greene-Cananea Co. in Mexico.

About 3 years ago Colonel Powell resigned as manager of the Calumet and Arizona, etc., and was succeeded by John C. Greenway, who is the present manager. Colonel Powell leaves a wife and several children who reside in Los Angeles, Cal.

Texas Coal Mining Outlook

Orders for Texas coal have been received from Southern Colorado, the Pan Handle of Texas, and other points in the Colorado trade territory. In 1912, the production of Texas coal was 2,188,612 tons, valued at $3,655,744. This was an increase of 214,019 tons.

The bituminous mines which are located in Eastland, Erath, Maverick, Palo Pinto, Webb, Wise, and Young counties, in 1912 produced 1,197,907 short tons, or 54 per cent. of the total production, and it had a mine value of $2,774,956. There were 990,705 short tons of lignite produced that year, with a value of $880,788. The lignite mines of Texas are located in the counties of Bastrop, Hopkins, Houston, Lee, Leon, Medina, Milam, Rains, Robertson, Titus, Van Zandt, and Wood. The leading bituminous producing counties are Eastland and Erath, and in 1912 produced more than two-thirds of the bituminous output. Lignite is produced chiefly in Wood County.

There were two fatalities in the Texas coal mines in 1912, or .38 killed per 1,000 employed, or .918 killed per million tons mined. This is probably the lowest death rate in any state for 1912.

Truesdale Breaker Record

The Truesdale breaker has been described in Mines and Minerals, February, 1906, and mentioned several times since. It has again come into prominence through its preparation of 105,020 tons of coal in the month of October, which is equivalent to 1,260,240 tons a year.

This is the largest quantity of coal ever put through one breaker; even then only one-half the breaker was used, the remainder not being equipped because development has not yet reached a stage where the present equipment is overtaxed. Each machine in this breaker is operated by an individual motor, and, should one machine break down, the arrangements are such the entire breaker is not stopped. Colonel Phillips, General Manager of the Coal Department of the Delaware, Lackawanna & Western Co., is to be congratulated on his foresight in constructing this breaker, and Harry G. Davis, District Superintendent, and his assistants, in developing the mines in this part of the field to a stage where so great a record can be made in so short a time.

NEW MINING MACHINERY

The Largest Mine Locomotive Ever Built

The Carnegie Coal Co. has recently installed at the Charleroi (Pa.) coal works two of the largest electric mine locomotives ever built. These locomotives weigh 30 tons apiece and are of the Baldwin-Westinghouse "barsteel" type. It is estimated that each locomotive can haul 100 cars each loaded with 3 tons of coal over the local grades.

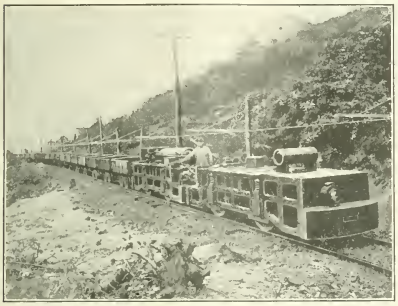


Fig. 1. Baldwin-Westinghouse 30-Ton Electric Locomotive Connected Tandem

Fig. 2. Unit of Double Locomotive Working Singly

The reasons for using such large locomotives are as follows: The Carnegie company recently acquired possession of the Charleroi mine, which is of considerable size and is well developed. A large production is desired from it, but the haul is about 2 miles long with the grade largely against the load. Hence the average haulage locomotive of from 15 to 25 tons would not be sufficiently large to keep production up to the estimated tonnage.

The locomotives possess a number of interesting features.

Each locomotive consists of two separate units which can be separated and used as 15-ton locomotives if desired. This use of two units in tandem is advantageous in such large machines because the weight is distributed over eight wheels instead of four, and hence the locomotive has great tractive power and is also easier on the track than if the weight were more concentrated.

The "barsteel" construction represents the most modern design. As is seen in Figs. 1 and 2, the frames are not built up of plates but are formed of a grid of steel bars of heavy cross-section. The side frame of each unit is cast separately, forming an extremely strong and rigid construction. The openings in the frame give ready access for inspecting, oiling, replacing brake shoes, adjusting brake rigging, etc., and also provide thorough ventilation to the electrical apparatus, so that its all-day efficiency is higher than would be the case if the frame were totally enclosing. This kind of frame has been in use for many years for large freight locomotives but has been only recently adapted for mine locomotives.

Air brakes are used, owing to the greater ease of handling so large an engine, but each unit is equipped with hand brakes which can be operated together from an operating stand on the leading unit. An auxiliary reservoir is provided on the trailing unit, the main reservoir and compressor being located on the leading unit. The hand brakes are operative on both units when disconnected for independent operation.

The controller for the tandem is of the individual magnetic blow-out type and handles all four motors at once. When the tandem is split, the four-motor controller handles the two motors of its unit without change in connection, while the other unit has its own two-motor controller.

In addition to the two large haulage units the Carnegie company has installed at Charleroi 10 traction-reel gathering locomotives or "crabs," also of the Baldwin-Westinghouse barsteel type.

The Jeffrey-Drennen Adjustable Turret Coal Cutter

*By C. E. Warbom, Engineer**

One of the new coal-cutting machines recently placed on the market by the Jeffrey Mfg. Co., of Columbus, Ohio, is known as the Jeffrey-Drennen adjustable turret coal cutter.

*Columbus, Ohio.

This was designed by the Jeffrey engineers at the request and the co-operation of Mr. Everett Drennen, manager of the Consolidation Coal Co.'s mines, Elkhorn Division, to meet certain conditions existing in the mines at Jenkins, Ky., and to economically mine the coal, also to improve its quality.

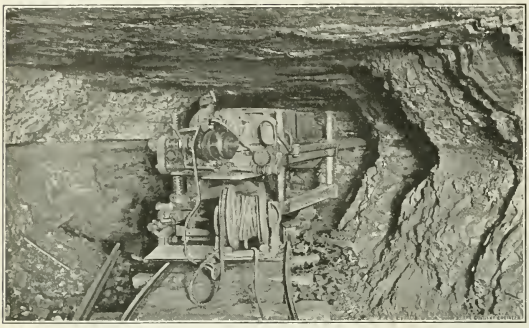


Fig. 3. Jeffrey-Drennen Coal Cutter, Beginning Cut

The coal seam at Jenkins varies from 6 feet to 8 feet in thickness, and is clean, bright, and free from sulphur or other impurities, with the exception of a shale band which varies in its position from 2 feet to 5 feet from the floor, and in thickness from nothing to 19 inches.

With the customary undercutting and blasting it is impossible to prevent the shale and coal from mixing, but this difficulty is overcome by the use of a machine adapted to cutting out the shale band before the coal is shot down.

The machine is mounted on a turntable truck which carries four heavy standards on which the machine is moved up or down, to the desired height to cut out the shale parting, if it is between 2 feet and 5 feet from the floor. A disk friction clutch operated by power enables the machine runner to control the raising and lowering of the machine at the rate of 5 feet in about 25 seconds. The machine is equipped with a reel which automatically winds or unwinds the cable as the machine enters or comes out of the room.

The machine is arranged for self-propulsion, and has a track speed up to 350 feet per minute, which is controlled through a disk friction clutch.

The width of the machine over all is 5 feet, length 17 feet, with an 8-foot cutter bar, and height of 5 feet 6 inches.

It has been found that by cutting the shale seam only two small shots are required for the top and two shots for the bottom bench, which lessens the danger of damaging the roof, and practically eliminates blown-out shots. The machine has been the means of giving a cleaner product of coal, of more rapid mining at less expense per ton, and furnishes a safer method of mining coal.

The entries in these mines are driven 10 feet and the rooms 15 feet in width. When the machine is moved into the room, an anchor hole $2\frac{1}{8}$ inches in diameter is first drilled in the coal under the shale band and about in line with the left-hand track rail. An anchor is fitted into this hole, and the feed-rope attached. The machine is then turned on the turret by hand toward the right-hand rib, making an angle of about 15 degrees with the track, at which point the cutter bar is automatically locked in position.

The machine is then pulled toward the face and started and the cutter bar forced into the coal to a depth of about 8 feet. When the cutter bar has reached the full depth of the cut, the feed-rope is attached to an extension arm which is securely bolted to the lower part of the truck, the rope being taken around a sheave, and the end fastened to the machine proper. With this hitching, the cutter bar is swung across the face, the speed of the cutter bar being about $32\frac{1}{2}$ inches per minute at its extreme end. The cut across the face is completed when the cutter bar stands at an angle of about 20 degrees to the left of the track, and it is again automatically locked. The feed-rope is then carried to the machine over proper sheave wheels, and attached

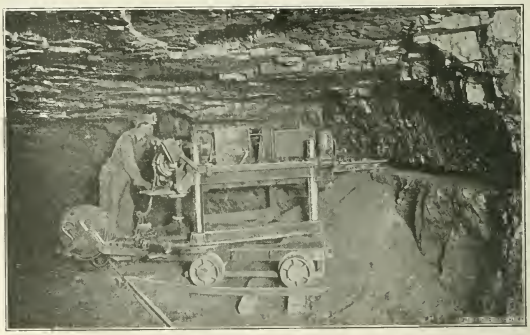


Fig. 4. Making Cut With Jeffrey-Drennen Coal Cutter

to a jack-pipe set 20 to 30 feet from the face between the track and the left-hand rib.

The feed is then started, and the machine with truck is pulled back, cutting the left-hand rib, as the machine is pulled from the face. When the cutter bar is clear of the rib, it is swung into a central position to the track, the machine lowered, the self-propelling gear thrown in, and it is then ready to be propelled by its own power to the next working place.

The cutting is done in the shale at the bottom of the band, with the bottom nose of the bits cutting into the coal about $\frac{1}{4}$ inch, which causes the shale to fall in the kerf, after which it is cleaned out, loaded in cars, and hauled out of the mine. This insures clean coal.

A 15-foot place can be cut in 11 minutes from the time the machine enters the room until it is ready to leave, and 25 rooms have been cut in a shift of 10 hours.

The first machine was installed some 8 months ago. The company now has 26 in operation.

Several coal companies have adopted the method of cutting coal beds in the center, the object being to minimize the danger from blown-out shots, to lessen the danger of damaging the roof, and to secure increased production at lower cost. A coal cutter that mines the coal without unloading the machine from its truck has a great advantage over other mining machines, and several

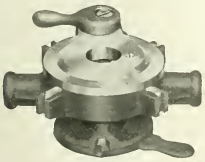


Fig. 5

operators in this country are installing machines of this kind. The Jeffrey-Drennen machine, on account of its high speed, both in cutting, adjustment, and self-propulsion, affords economical mining and renders the work safer.

"Bulldog" Die Stock

The "Bulldog" die stock, shown in Fig. 5, threads four sizes of pipe, $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch, and $\frac{3}{4}$ inch, on one set of double-end dies. The outer ends of these dies are protected from injury by a patented casing which in turn protects the user's hands. The dies are set automatically at the proper place. The form shown in the figure combines the regular "Bulldog" features of self-locking dies and guides, no running back over the finished threads, no resetting after each cut, and has no extra dies, loose bushings, or loose parts of any sort. The makers are the Oster Mfg. Co., 2091 E. 61st St., Cleveland, Ohio, who make hand-, belt-, or motor-operated pipe threading tools of all sizes and styles. Their complete catalog can be had for the asking.

A New Anemometer

In placing a new line of anemometers on the market, the chief object in view of the Davis Instrument Mfg. Co., Inc., of Baltimore, Md., was to offer instruments to give uniform observations, no matter what the size or readings, and to construct them with a permanent adjustment which would not be disturbed by use.

With this idea always present, Mr. A. U. Davis designed tubular spokes for the vanes, inserted in the calibrating hub at always the same pitch, to supercede the method of hand twisting the arms or spokes which nearly all previous makers cut out from sheet metal the center of which formed the hub.

It is well known that twisted metal makes an unreliable scientific adjustment, particularly if sustaining variable strains and it is to this cause that much of the irregularity of readings by the anemometer is due; many mining officials have noticed that anemometers give increased readings with use, and if the reason is searched for by experiment it will always be found that the vanes have become more exposed from the tendency of the twisted vane arms to untwist.

Apart from the design of the tubular spokes for the vanes, little originality is claimed, further than the manufacture throughout has been standardized and made by the latest American precision machine methods. The vanes are so nicely balanced that

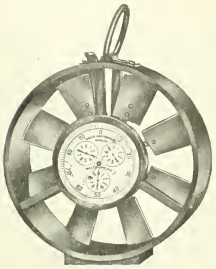


Fig. 6. New Davis Anemometer

the speed may be run up to 2,000 feet without injury to the instrument, and the instrument is also exceedingly sensitive to low speeds. They are constructed to register from 1,000 to 100,000 feet.

TRADE NOTICES

Steam Pipe Covering.—The H. W. Johns-Manville Co. state that recent tests made by Prof. C. L. Norton, of the Massachusetts Institute of Technology, show that the yearly cost of maintaining 100 square feet of pipe at 100 pounds gauge pressure is, for bare pipes, $225; for 1-inch molded insulation, $35.90; and for 1-inch J-M Asbesto-Sponge only $25.40. This Asbesto-Sponge covering is made of layers of thin felt composed of pure asbestos fiber and finely ground sponge. It is tough and flexible so that vibration, moisture, heat or rough usage will not cause it to break, crack, crumble or lose its insulating efficiency. It is absolutely fireproof and can be removed and replaced an indefinite number of times without deterioration. The manufacturers have some remarkable test data which, together with their catalog, they will mail to any one interested.

Purchase of Ernst-Wiener Co. Announcement is made of the purchase of the stock, rights, plant, office records, equipment and "goodwill" of the Ernst-Wiener Co., by the Easton Car and Construction Co., of which W. E. Farrell is the head. The Easton Car and Construction Co. is an entirely new organization, and the change in ownership is complete. The company has a newly erected plant at Easton, Pa., that is equipped with new and special machinery, adapted to the fabrication of the well-known Ernst-Wiener line. Everything will be sold hereafter under the trade name of the Easton Car and Construction Co., and the new organization is in position to effect immediate deliveries.

Safety Setscrews.—The danger of ordinary setscrews on revolving machinery is shown by the numerous accidents where people have been caught by the clothing and revolved on shafting or drawn into machines. As a means of avoiding this danger, setscrews sunk below the surface have been recommended. The Goodwin patent hollow safety setscrew, which is made by The Bristol Co., of Waterbury, Conn., has no projecting part and the wrench is inserted into the hollow head, the slot being of such shape that the screw may be operated with a screwdriver or any flat piece of metal of suitable size if the special wrench is not at hand. When the proper wrench is used, however, the dovetailed form of the slot causes it to hold firmly under strain without tendency to spread the screw. These screws cost little, if any, more than the ordinary dangerous ones and can be had in any size and form of point. The Bristol Co. has acquired the sole rights for their manufacture and will send full particulars on request.

Electricity at Mines.—The increase in the use of electric apparatus at mines is shown by the large numbers of orders received by the General Electric Co. for additions to plants already in operation or for entire equipments for mines being opened or to replace other forms of power. These include Curtis turbines, generators, mining locomotives, motors of all sizes, together with switchboards, converters and line material and come from all parts of the country.

Announcements.—A recent addition to the staff of the centrifugal pump department of the A. S. Cameron Steam Pump Works, New York, is C. V. Kerr, the organizer of the Kerr Turbine Co., and later with McEwen Bros., of Wellsville, New York. Mr. Kerr delivered an interesting address with stereopticon views on "A New Centrifugal Pump with Helical Impeller," at the monthly meeting, November 11, of American Society of Mechanical Engineers, at their rooms, New York City. Reference to this subject in extended form appeared in the October number of the Journal of the Society.

Myron G. Doll, for several years local manager for the Sullivan Machinery Co., at Salt Lake City, has resigned, and H. F. Moon, formerly with the Denver office of that company, has been appointed his successor. Mr. Doll has accepted the position of General Sales Manager of the Bury Compressor Co., at Erie, Pa.

C. L. Newcomb, Jr., has been appointed to succeed G. B. Turner as western representative of the Goulds Mfg. Co., of Seneca Falls, N. Y. Mr. Newcomb's headquarters will be at 12 Chamber of Commerce, Denver, Colo.

Catalogs Received

The United States Graphite Co., Saginaw, Mich. "What Users Say About It," 63 pages; Talking Points and General Information, 28 pages.

Ingersoll-Rand Co., 11 Broadway, N. Y. "Calyx Bore Holes," 16 pages.

The Bristol Co., Waterbury, Conn. Circular, Goodwin Hollow Safety Setscrews.

National Tube Co., Pittsburg, Pa. Circular, The "Kewanee" Union.

American Pulverizer Co., East St. Louis, Ill. "The Ring is the Why," 15 pages.

G. L. Simonds & Co., 115 So. La Salle St., Chicago, Ill. Vulcan Soot Cleaner, 48 pages.

American Concentrator Co., Philadelphia, Pa. What We Do, 16 pages.

Mesta Machine Co., Pittsburg, Pa. Mesta Gas Engines, 8 pages.

Fairmont Mining Machinery Co., Fairmont, W. Va. Fairmont Coal Mine Equipment Bulletins.

The Borden Co., Warren, Ohio. High-Grade Cutting and Threading Tools, 24 pages.

The Denver Engineering Works Co., Denver, Colo. Open Front Stamp Mortar Improved Ore Feeder, 4 pages; Ovoca Classifier, 8 pages.

The Bristol Company, Waterbury, Conn. Wm. H. Bristol Electric Pyrometers, Catalog No. 1400, 63 pages.

The Star Manufacturing Co., New Lexington, Ohio. Circular, The Star Mine Cars.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 34-D, "Chicago Pneumatic" Corliss Compressors, Steam Driven, 32 pages.

General Electric Co., Schenectady, N. Y. Bulletin No. A4151, Engine Driven Continuous Current Generators, Commutating Pole Type, 11 pages; Bulletin A4131, Storage Battery Industrial and Mining Locomotives, 19 pages.

De La Vergne Machine Co., foot of East 138th St., New York, N. Y. The "De La Vergne" Oil Engine "FH," 15 pages.

E. I. Du Pont de Nemours Powder Co., Wilmington, Del., Crop Increase by using Du Pont Red Cross Dynamite, Circular.

At 62° F., 1-foot head of water exerts a pressure of .433 pound per square inch; or .433 × 144 = 62.352 pounds per square foot. This pressure is the weight of 1 cubic foot of water.

The Colliery Engineer

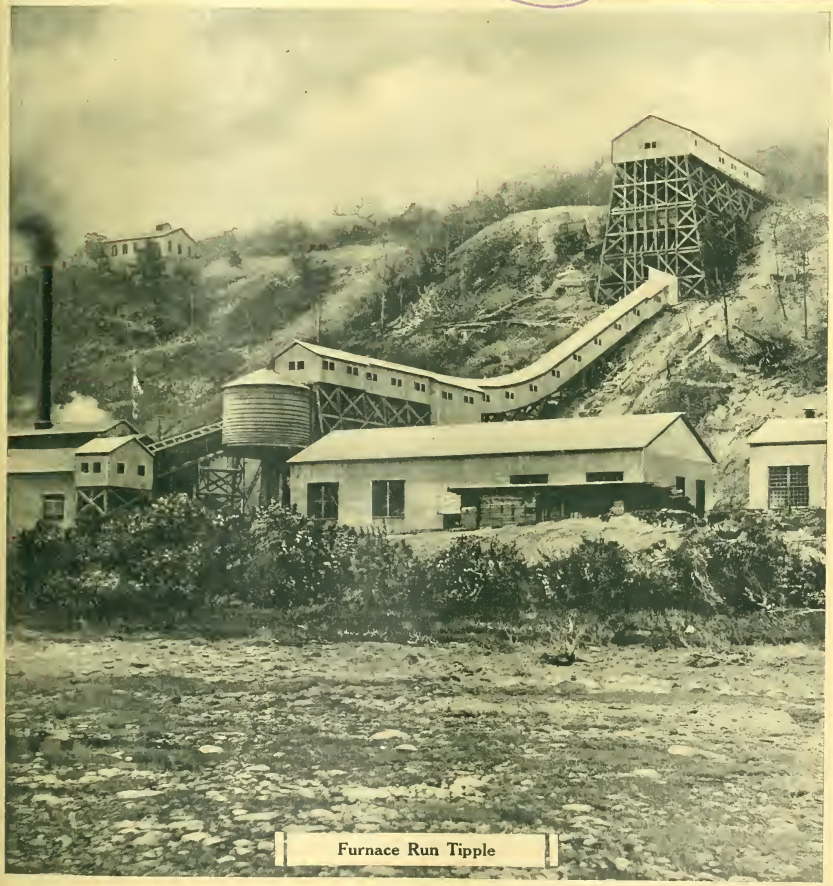
Formerly Mines and Minerals

ol. XXXIV—No. 6 JANUARY, 1914 Scranton, Pa.

habetical List of Advertisers—Page 60

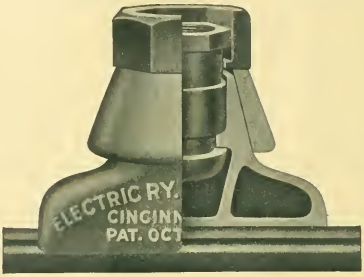
Classified List of Advertisers—Pages 62, 64, 66, and 68

LIBRARY JAN 5 1914 UNIVERSITY OF TORONTO



Furnace Run Tipple

The "SURE GRIP" on Trolley Lines



means absolute safety

For once the "Sure Grip" clamp gets a hold on the wire it's there to stay. The possibility of hanging wires and consequent accidents to men is absolutely eliminated.

The Sure Grip is a positive safety device for trolley lines. It makes men feel safe—helps them to do more and better work because they **know** the absence of this common danger.

Made in all sizes. 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.
H. G. Behneman
316 James St., Seattle, Wash.
Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.
Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.
Mine & Smelter Supply Co.
Denver, Colo.
Mine & Smelter Supply Co.
El Paso, Texas

Mine and Smelter Supply Co.
Salt Lake City, Utah
C. M. McClung & Co.
Knoxville, Tenn.
McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.
Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.
Arthur L. Ware
Jellico, Tenn.
Superior Supply Co.
Bluefield, W. Va.

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

For a Family

Mines and Minerals

Vol. XXXIV—No. 6 JANUARY, 1914 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1891

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE, 14,500

TABLE OF CONTENTS

Editorial Notes—What Is a Fatal Mine Accident?—Non-Hazardous Mines—A False Doctrine—The Bureau of Mines—As to Business Regulation 329

Personals 332

Furnace Run Mines, by W. Z. Price 333

Porcupine Column-Pipe Cleaner 337

Spitzbergen Coal 337

Electric Mine Haulage, by Eric A. Lof 338

Water Softeners 343

Testing for Firedamp with Wire Loop, by Henry Briggs 344

The Smoky River Coal Field, by Frank O'Neal 346

Prospecting Bering River Coal Field, by W. R. Crane 347

The First Connellsville Ovens 350

The Origin of Coal, by Wilbur Greeley Burroughs 351

The National Conservation Congress 353

The Mount Pleasant Bath House 354

German Rescue Organization, by Bergassessor Breyhan 355

The Purchase of Lubricating Oil 357

Prize Gardens at Weyanoke 358

Change in Alberta Mine Laws, by Norman Fraser 360

Automatic Mine Door at Seneca 360

Mine Accounting, by J. B. L. Hornblower 362

The Selection of Coke Samples, by Fred C. Keighley 363

New Houses for Miners 364

Dawson, New Mexico, Mine Disaster 365

The Clinkering of Mixed Coals, by R. D. Quickel 368

Obituary—

William H. Storrs 371

Mining Institute Meetings—

Coal Mining Institute of America, 372—Kentucky Mining Institute, 373—Illinois Mining Institute 373—West Virginia Mining Institute, 374—Scranton Mining Institute 376

Some Notes on Mines and Mining 377

Banquet to Doctor Miller 377

Prize Contest 378

Book Review 380

Letter Box—

Effect on Roof of Dewatering Flooded Mine—"The Wisest Man"—Pumping Coal to Market—An Emergency Hospital—Mine Safety Association—Explanation of Formulas 381

Real Heroism 382

Examination Questions—

First-Class Candidates, British Columbia, May, 1913 383

Practical Talks on Coal Mining—

Mechanics of Mining, 387—Electricity in Mines, 389—Mine Ventilation 390

New Mining Machinery—

Pocket Mining Hygrometer—A New Recording Hygrometer—New Two-Stage Air Compressor—Feeding Graphite to Boilers—Kewanee Air-Pump Union—A Lubricating System 391

Trade Notices 393

Catalogs Received 394

Squibs—

Air Cylinder Lubrication, 347—Briquets in France, 354—1912 Coal and Coke Production, 361—Hard and Soft Water, 363—Combustion at High Altitudes, 366—Correction, 366—Employes' Magazine, 381—Timber from National Forests, 381—The "Battleship," 386—Appointment of R. B. Cobb. 390

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY ALL RIGHTS RESERVED

MAY the New Year be a happy, safe, and prosperous one to all readers of THE COLLIERY ENGINEER.

WE WERE recently asked to express an opinion as to the prospects of the coal trade in the year 1914. As we are not prophets nor sons of prophets, all we could say was, "if you can tell us what effect the new tariff bill will have on American industries, we can make a fairly close approximation." Even if experience shows that the changed conditions do not materially affect the industries generally, the uncertainty that will prevail for the first few months of the year, will, without doubt, adversely affect the market for steam coal and coke.

FOR refusing to comply with a requirement of the "Davis act," enacted by the last Legislature of Pennsylvania, Col. R. A. Phillips, General Manager of the Lackawanna Coal Co., and Mr. C. C. Rose, General Manager of the Hudson Coal Co., were recently fined $1,000 each in a magistrate's court at Scranton, Pa. Both gentlemen immediately entered appeals, and the matter will be carried to the higher courts. The Davis act providing for a city mine commission, in connection with the question of surface support, contains provisions that the managements of the larger mining companies are advised are unconstitutional. Besides, the carrying of the appeals to the higher courts will settle, in the quickest possible way, questions at issue between the owners of real estate in certain sections of the city of Scranton, and the separate owners of the coal underlying that real estate. Both Messrs. Phillips and Rose will undoubtedly cooperate with the city authorities in all reasonable efforts to have the questions at issue speedily settled, and thus aid in ending agitation that is doing incalculable damage to the growth and prosperity of the city, through exaggerated newspaper accounts of surface settlements in some sections of the municipality.

What is a Fatal Mine Accident?

THE definition of a fatal mine accident seems relatively easy to answer; namely, an accident which caused the death of a mine worker. However, if the man lives 31 days after the accident in Ohio, 61 days in West Virginia, or 91 days in Illinois, and then dies,

the man's family is not entitled to compensation under the laws of those states. Assume that the man's neck was broken. No one has ever lived and been able to work afterwards, although the surgeons may patch up a man so he may live a year or so, therefore the man is practically dead from the time of his accident, and yet his family could not obtain compensation. This difficult question arises because the element time must enter into law. Another question also is raised; namely, Did the man die from his injuries or because of improper treatment by the surgeon?

There is now a case in the Pennsylvania courts where a coal company is being sued because members of a first-aid team did not set a bone properly. As compensation laws will probably be enacted in Pennsylvania and elsewhere and a determination is necessary in order to keep statistics of accidents in coal mines, James E. Roderick, Chief of the Department of Mines in Pennsylvania, requested the bituminous mine inspectors of that state to meet with the representatives of the United States Bureau of Mines and decide, if possible, what is a fatal accident. After discussing the knotty subject pro and con one whole day, the commission could come to no definite conclusion because of that element, time.

Of course, a conclusion must be reached, and it is possible that some of our readers may be able to help, as they are the ones most interested.

Non-Hazardous Mines

THE attention of The Colliery Engineer was recently called to the following news clipping:

To insure stricter supervision of the mines in West Virginia where the danger is greatest during the present season of the year, Gov. H. D. Hatfield is advising with Earl A. Henry, Chief of the State Department of Mines, in establishing a system of classification of the mines into three divisions: non-hazardous, hazardous, and extra hazardous.

The governor's plan is to assign the district mine inspectors so as to provide inspections of the extra hazardous mines oftener than the non-hazardous, to prevent explosions as far as possible. A movement will be made to have this system used as a basis of liability to be charged under the workingmen's compensation law, the rates to be fixed in proportion to the hazard.

Most of us are familiar with hazardous and extra-hazardous mines, but with the non-hazardous coal mines we have yet to become acquainted. The old story of "the model mine" is known to all, as the mines considered the safest are frequently the scenes of great disasters. Just where and how the West Virginia Department of Mines will comply with the Governor's desire by making the lines between the mines of various degrees of safety, is at present hard to understand.

One prominent mining man, writing to The Colliery Engineer on the subject, aptly says:

"If that classification is ever finished and any non-hazardous mines are found, I am going to make a special trip to see one. The hazardous and extreme hazardous mines I have seen, but the former will do me good to see."

A False Doctrine

AT the recent meeting of the Coal Mining Institute of America, in a discussion, one member expressed the sentiment that miners should not be too highly educated, as it made them dissatisfied.

Lack of education and intelligence among mine workers are responsible for many accidents to life and property; therefore, by the same token, the occurrence of accidents should be encouraged.

Miners who are educated to a greater or less extent are the miners who earn most. They are susceptible to reason and are not easily influenced by trouble makers. The illiterate, ignorant man is the one who is most troublesome. The old English idea of men being satisfied "with the lot in which it has pleased God to place them," never found favor in America, and is considered by progressive Englishmen as an obsolete pernicious doctrine. Progress, industrially, socially, and in every other way has its incentive in dissatisfaction. If men were not dissatisfied, there would be no progress. Most of the ablest mining engineers, colliery managers, and subordinate mine officials in both England and America are men who had the ambition and natural intelligence to refute the false doctrine of years ago. They were dissatisfied and they rose above the "state of life in which it had pleased God to place them," and in doing so, they exercised their God-given right to make their lives more useful and valuable to themselves, their families and their communities.

Twenty-five years ago, the then president of a large coal mining company opposed the education of mine workers because it would make them dissatisfied. Under his management the company was practically bankrupt. Its stock, to use a broker's expression, "was used as a football" in financial circles. Time passed. The present manager of the same company is a self-educated man. The present president of the corporation is a broad-minded man of superior executive ability. He wisely has implicit confidence in the ability and judgment of the self-educated manager. As a result, that mining company is mining several times more coal, and coal that is more expensive and more difficult to mine, than was the case 25 years ago, and it is mining it with fewer fatalities and at a profit. It is no longer a practically bankrupt company. This same manager encourages the education of the mine workers by every means in his power, because he knows that greater intelligence and broader education means greater efficiency. He is not alone in such ideas. Most of the managers of the large American coal mining companies have the same belief in education that he has. The idea that too much education for workingmen is detrimental to any industry is false, inhuman, and absolutely un-American. All workingmen will not, or cannot, acquire education. Those who do not are those whom the world will cause to do the work that must be done by human machines. But the mine worker who, through personal sacrifice, educates himself so that his

dissatisfaction can be made satisfaction in a position above that "in which it pleased God to place him," is the type of man represented in a large majority of the members of the Coal Mining Institute of America and similar organizations. They are useful men to the coal mining industry, their local communities, and the nation. The man "who knows it all" and cannot learn anything more, the man who believes in obsolete false ideas as to the acquirement of knowledge has, in this day, outlived his usefulness.

The Bureau of Mines

PRESIDENT WILSON in his message to Congress, devoted a paragraph to the Bureau of Mines, in which he said:

"Our Bureau of Mines ought to be equipped and empowered to render even more effectual service than it renders now in improving the conditions of mine labor and making the mines more economically productive as well as more safe. This is an all-important part of the work of conservation; and the conservation of human life and energy lies even nearer to our interests than the preservation from waste of our material resources."

That it ought to be equipped to render more effectual service is a sentiment with which we agree, but we do not believe it is necessary or desirable that its powers be increased. The control of the safe and proper working of the mines in each state is the province of the state. All coal mining states have inspection departments of greater or less efficiency. They all should be of the greatest efficiency. This end can be hastened by the Bureau of Mines in an educational way. The Bureau now works in more or less harmony with the mining departments of the several states. Where there is even quiet opposition to the Bureau it is due generally to the assumption of unwarranted authority on the part of some one connected with the Bureau, or to some misunderstanding of its attitude.

The Bureau of Mines is a new institution. It has done a great deal of excellent work. It has made some mistakes, and in some instances has claimed credit that did not belong to it. That there is hostility to it on the part of some managers cannot be denied. This is not due to opposition to the Bureau's functions of increasing safety to life and property, and the conservation of the country's mineral resources. It is due to ill-advised statements made officially by some officers of the Bureau and to unwarranted interference in some instances by employes, with the duties of mine managers. Some of these interferences, we have no doubt, were purely imaginary.

As a whole, the coal mine managers and officials, as well as the mine inspectors of most states, are kindly disposed toward the Bureau, even if some few have not, as yet, actively supported its work.

The Bureau of Mines, in addition to its specified duties, must prove to all men engaged in mining, that it is not a meddlesome institution, but is intended to be a source of help and information.

We have, from time to time, freely criticized the Bureau, and have not refrained from specifically criticizing its head, regardless of the fact that personally the relations existing between the writer and Doctor Holmes and many of his assistants always have been, and are most friendly.

Doctor Holmes had the task of organizing the Bureau without any precedent to guide him. That he has accomplished what he has done with so little to criticize, should commend his work to all mine officials. He was limited in his work by the appropriations made by the Bureau, and by more or less opposition from some mine owners, mine managers, and mining engineers. His Bureau has power enough, but not money enough to make it as efficient as it should be. To give it more power will likely cause more friction, and increase the number of those who are not now friendly to it. Time will give Doctor Holmes experience in dealing with unprecedented questions, and will educate many now unfriendly to the Bureau to a different attitude. More funds supplied by the Government for the carrying on of the work of the Bureau, a little more diplomacy used by some few of its attaches, and finally a disposition on the part of all mine managers and officials to cooperate with the Bureau, both in the matter of giving information and advice, and kindly criticism as well, will result in making it of great value to the mining industry generally.

As to Business Regulation

AN effectual way to stop a toothache is to decapitate the victim. Certain evils that have crept into American industrial operations can be effectually cured by killing the industries. The toothache cure is no more ridiculous than the cure for industrial abuses. The alleged statesmen at Washington, who advocate the destruction of vast businesses so as to correct evils that have crept into them, would be consistent if they would advocate the effectual cure for toothache mentioned above. However, consistency cannot be expected in men whose every action is taken with the sole object of posing as the champions of the unthinking masses, and personally profiting thereby.

Large combinations of capital in industrial operations have been made necessary by the remarkable world-wide developments of the past 50 years. If abuses have attended the growth of large industrial corporations, the abuses should be corrected. There is no necessity of killing the industries.

So-called trusts have not all been burdensome on the general public. In many instances they have produced and sold their products at lower prices than had ever been previously known. In other instances they have taken up disorganized industries, and by rational regulation and management they have made them profitable, and in so doing have given thousands of workingmen steady work at fair wages.

To say that some combinations of capital, popularly designated trusts, have not taken advantage of their power and placed burdensome conditions on certain sections of the country would be untrue. It is just as untrue to say that all combinations of capital have imposed burdensome conditions on the people.

There is no sense in punishing the innocent for the faults of the guilty, and there is no sense in killing the business of those guilty of minor offenses, when those minor offenses can be stopped without loss to the capital invested or the labor employed.

"Trust busters" may be more popular today than political economists, but the day is rapidly coming when the whole nation will realize that a great mistake was made when general industrial remedies that tend to kill, instead of direct treatment that would tend to cure the industries were used.

When that time comes there will be a number of politicians ready to indorse the philosophic Lincoln's statement that "you can fool all the people some of the time, and some of the people all the time, but you can't fool all the people all of the time."

PERSONALS

The Berwind-White Coal Mining Co., makes the following announcement relative to the resignation of Walter R. Calverley, as general superintendent: "The duties of the position formerly held by Walter R. Calverley, at Windber, have been divided among the present employes, and the office of general superintendent, as held by him, has been abolished."

The Lehigh Valley Coal Co. has announced the following appointments: As district superintendent in the Wyoming Division, to fill the vacancy caused by the death of District Superintendent Joseph J. Jones, J. S. Hammonds, formerly district superintendent at Henry, Mineral Springs, Franklin, and Warrior Run collieries, to be district superintendent at Henry, Prospect, and Dorrance collieries; and Sheldon Jones, formerly assistant district superintendent at Prospect colliery, to be district superintendent at Mineral Spring, Franklin, and Warrior Run collieries.

Isaac Murray has been appointed deputy mine inspector, for the 10th district of West Virginia, to succeed E. J. Flanagan, who has resigned on account of ill health. Mr. Murray will probably have his headquarters at Oak Hill.

Elmer O. Long, assistant chief engineer of the Consolidation Coal Co. in Somerset County, has tendered his resignation and will engage in business with Frank B. Flick, mining engineer and engineer for Somerset borough. Charles Ling succeeds George B. Glennas, general manager of the Sunnyside Coal Co., at Johnstown.

The State Mining Board of Illinois announces the list of successful applicants at the recent examination for state mine inspectors. Those eligible to appointment are: David E. Wall, Springfield; John Garrity, Riverton; David Z. Thrus, Farmington; William Hartman, Bellevue; John Kaney, Centralia; Thomas F. Myers, Marion; John E. Jones, Danville; John McClintock, Murphysboro; James S. Reid, Carterville; R. E. M. Coulson, Glen Carbon; J. W. Starks, Georgetown; James Haskins, Catlin; J. W. Siddell, Tower Hill; George L. Morgan, Benton; J. C. Duncan, Benton; Patrick Hogan, Canton; Thomas H. Devlin, Assumption; Ben D. Roberts, Streator; Archibald Frew, Gillespie.

M. M. Bardell, who was formerly located in Louisville, as general manager of the coal companies in which Bryne & Speed, of Louisville, are interested, has transferred his offices to the Western Kentucky operation of the Taylor Coal Co., at Beaver Dam.

Charles Lathrop Peck was again unanimously elected president of the National Conservation Congress.

J. J. Stoker, of Johnstown, for 12 years or more in the employ of the Cambria Steel Co., in its mining department, has been appointed an inspector of a bituminous district, and is temporarily assigned to the district of Inspector Chauncey Ross, of Latrobe,. who has been in poor health lately. Mr. Stoker, has had a varied experience in mining affairs with coal companies in the central Pennsylvania district.

It is now the proper form to address our old friend E. V. D'Invilliers, geologist and mining engineer, of Philadelphia, as *Doctor* D'Invilliers. His *alma mater*, the University of Pennsylvania, recently conferred on him the honorary degree of Doctor of Science. Doctor D'Invilliers graduated from the University in the class of 1878, and he has been honored by his classmates by being chosen president of his class every year since that date.

Edmund B. Jermyn, manager of Jermyn & Co.'s collieries in the Lackawanna Valley, was elected Mayor of Scranton, Pa., by one of the largest majorities ever given a mayoralty candidate in that city. Mr. Jermyn's victory was a nonpartisan one, the principal points of the platform on which he ran being "the business of the municipal corporation must be administered with the same efficiency and economy as the industrial corporation." He will assume the duties of his office on January 5, and his term will extend over a period of 4 years.

Patrick J. Tormay has retired from the position of superintendent of the Trotter plant of the H. C. Frick Coke Co. He was one of the oldest employes of the company, having concluded 25 years in its employ in various capacities, from laborer to that of superintendent. Go dtugaidh Dia do Saoghal fada sochrach compordach is i suil i "Hogan."

COAL MINING & PREPARATION

The Furnace Run Mines

A Description of the Equipment of Two Mines of the Allegheny River Mining Co., near Kittanning, Pa.

By William Z. Price

THE Furnace Run mines are located on the west bank of the Allegheny River, near the town of Kittanning, Pa., on the Pittsburg and Shawmut Railroad, and are the last of five large plants constructed by the Allegheny River Mining Co., having a combined production of 1,750,000 tons per annum. The coal now owned by this company comprises over 30,000 acres, and an acreage equally as large is under control.

The property tributary to this operation comprises from 6,000 to 8,000 acres and is to be developed by two mines, each having its own town and designated as Furnace Run No. 1 and No. 2. The operation is practically new, as development work first began in July, 1912, but all the equipment is in place and the mines are shipping coal.

The seams of minable thickness in this section are the Upper Freeport and Lower Kittanning. The surface rocks here embrace some 800 feet of measures, in which are included a portion of the Lower Barren group, all of the Lower Productive coal measures, the Pottsville Conglomerate, the Mauch Chunk shales, and a part of the Pocono sandstone. The two seams are quite uniform in thickness and maintain an average interval of 180 feet between them. The dip of the rocks is toward the south. Two center dips in fact here meet each other and produce this southerly incline—one toward the northeast across the river, the other toward the southwest. The measures are not entirely normal, certain minor features of the group, as for example, the Johnstown cement and the Freeport lower limestone being absent. Sections of the rocks in hills facing each other on the two sides of the river are not the same, the principal variance being the vertical distance between the Lower Kittanning and the ferriferous limestone, beneath.

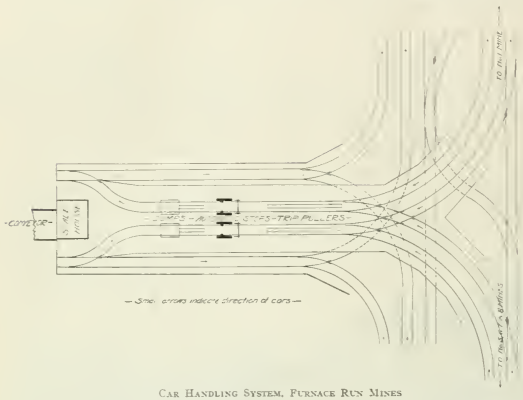
PLANT AT FURNACE RUN MINES

Both mines are worked on the room-and-pillar system, in panels containing 30 rooms. Main entries are driven in groups of four, two haulage entries in the middle with an airway on each side. The room

or butt entries are driven on the double-entry system, that is, one haulage road and an airway driven parallel. The gauge of the mine track is 42 inches. Forty-pound rails are laid outside and in the main haulage roads, 30 and 16-pound rails in the butt entries and rooms, respectively. In the rooms the rails are laid on Fairmont steel mine ties.

wire is strung along the top of each pole and grounded at every fifth pole. This acts as a lightning arrester. The poles are spaced from 100 to 125 feet apart. Motor-generator sets transform the current to 250-volt direct-current where needed.

Beginning with Mine No. 2, there are two openings, No. 7 and No. 8



Car Handling System, Furnace Run Mines

In both mines, the entries were driven with Jeffrey breast machines and the rooms with Sullivan continuous-cutting mining machines.

Three-ton Goodman gathering locomotives are used, and then the cars are taken to a side track by an 8-ton Jeffrey, where they are picked up by a 15-ton Jeffrey and hauled to the tipple. At Mine No. 1 an exception is made in this case, for, owing to its proximity to the tipple, the 8-ton locomotives take the cars right on to the approach. Every piece of machinery about the plant is electrically driven or operated. Steam power is used only for driving the generators in the power house.

Grooved 4-0 trolley wire is used and the rails equipped with 2-0 flexible compression bonds. Power is transmitted from the power house over 2,400-volt, alternating-current mains on poles, the cross-arms of which are 30 feet from the ground. No. 3 wire is used. A static No. 6

drifts in the Upper Freeport seam, which averages 42 inches in thickness. These drifts enter the ground at a distance of about 150 feet apart and almost at right angles to each other owing to the contour of the ravine at that point.

An 8-foot Stine disk fan is placed between the openings and serves as a ventilator for both mines. The fan is driven by means of a 40-horsepower, 2,200-volt, induction motor with a Link-Belt silent-chain drive.

At the present time the only other building near the drift mouths is the substation, which consists of a 200-kilowatt, synchronous motor-generator set with switchboard, oil switch, etc., built by the Ridgway Dynamo and Engine Co. In the immediate future a repair and blacksmith shop, together with an emergency hospital, will be added. The coal is of an easy cleavage and excellent for steam purposes.

About 200 yards north of the drift mouths is the new town of 50 houses laid out with streets and alleys. The company, in building the town, deviated from the usual custom of making all houses alike, so different designs are seen as well as houses of different colors. The water supply is excellent. Water is pumped from a deep well into a 20,000-gallon tank and distributed throughout the town in 3-inch and 4-inch cast-iron water mains to fire-plugs and hydrants. This will be known as Furnace Run No. 2.

From the mouth of No. 7 and 8 drifts, the yard for the mine cars extends 1,000 feet east toward Mine No. 1. There are three tracks the full distance. It will be noted in the accompanying figures that sturdy poles are used for the motor road. All the timber and lumber used about the entire plant came from the property.

The cross-arms supporting the trolley wires are 2-inch cast-iron pipes, which afford great rigidity and this minimizes repair costs and provides greater efficiency for the line.

Along the haulage road to the tipple there are Western Electric mine telephones attached at intervals to the poles. These telephones are numbered and their location is noted on the mine maps. The telephones connect with the mine office and the power house and in case of a breakdown or accident of any kind along the road, the position of the trip can be ascertained at once.

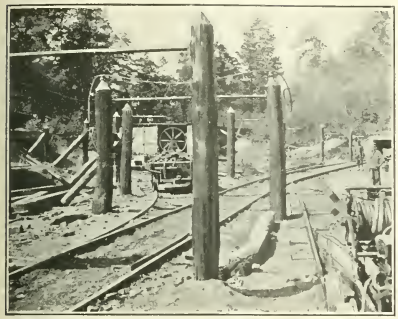
No. 1 mine consists of drifts Nos. 1, 2, 3, 4, 5, and 6 in the Lower Kittanning seam. Nos. 1, 5, and 6 are haulage drifts, the others being used for development work only, although Nos. 3 and 4 are now used as manways. All drifts have but one track, except No. 1, which is double tracked. Nos. 5 and 6 drift mouths are located about 3,000 feet west of the river from the haulage road from No. 2 mine. No. 1 drift is about 500 feet south of the tipple. Beside the buildings at No. 1 mine, such as the tipple, office, and supply

house, sand house, mine foreman's office, repair shop, and motor barn, an emergency hospital will be erected.

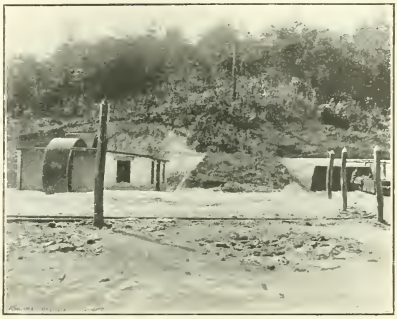
A 10-foot Jeffrey reversible fan acts as an exhaust ventilator for No. 1 mine. It is driven by a two-speed motor with a Link-Belt silent-chain drive. The fan house is built of brick and thoroughly substantial.

power motor and a main head-shaft. Between the motor and the head-shaft is a Webster steel-plate friction clutch, operated by a lever conveniently situated within the reach of the top man. Independent control of each puller is provided for by a clutch in its geared drive from the main head-shaft. The pullers are each 28 feet long to the centers of

the coal is weighed, then lowered 30 feet into a 250-ton bin. Owing to there being two dumps, there are two baskets and two scales used. The baskets, similar to a clam shell bucket, are made by the Fairmont Mining Machinery Co. From this bin the coal runs into a covered sheet-iron chute 2 feet high and 4 feet wide leading on to the recipro-



Drift No. 7 at Left, No. 8 at Right, Stine Fan in Center



Jeffrey 10-Foot Fan at Left, No. 1 Drift at Right

The tipple is equipped with the Webster system of handling mine cars which delivers the cars one at a time from the trip on the tipple approach, to and on to the dump. This work is done by two separate devices, a trip puller, at the tipple entrance, and an automatic stop and feeder just before the dump. The operation is rapid and economical of labor, and is conducive to the safety of man and dump by keeping the cars always under perfect control. The tipple was built to use this car handling system.

The loaded mine cars are drawn slowly forward on to the tipple floor by the trip pullers, one for each track, then the top man uncouples the cars so that as they pass the pullers they may run forward to the stops at the dumps.

Each trip puller consists of a strand of steel bar-link chain of 12-inch pitch, carrying, every 10 feet, a roller-supported dog of the knock-over type to engage the car axles. Both are driven from one 15-horse-

the sprocket wheels and are designed to handle a trip of 40 cars delivering them at a rate of four per minute. This gives the two tracks and dumps a capacity of 480 cars per hour.

The cars, as released from the pullers, run forward toward the dump but are checked by spring stops at the feeders. The forward car is thus held while its predecessor is dumped. The dump operator releases the loads one at a time, each loaded car running forward by gravity, bumps the empty car off the dump and takes its place ready for dumping. Phillips cross-over dumps are used and the operation of the tipple requires only three men, one at the trip puller and one at each dump. The feeder protects the dump and the men from injury by runaway cars. The feeders are patented by the Dempcy-Degener Co., the Pittsburg representatives of the Webster Manufacturing Co.

The coal is dumped into a chute which discharges into baskets suspended from a Fairbanks scale and

cating feeder, which discharges the coal into the conveyer.

The feeder is operated by a 10-horsepower General Electric, alternating-current motor. The length of its stroke is adjustable.

The conveyer is probably the first retarding conveyer for bituminous coal in Pennsylvania. It is about 300 feet long on a pitch of 27 degrees rounding off on a parabolic curve until it is horizontal, the last 50 feet extending over the railroad tracks. Conveyer flights are 16 in. × 48 in., and spaced 4 feet between centers. The conveyer is operated by a 75-horsepower General Electric alternating-current motor.

Near the base of the incline on the horizontal section of the conveyer is an opening through which the coal drops as it arrives at that point; however, should there, for any reason, be no demand for the coal at the time, owing to lack of cars, etc., the opening is closed by a sliding sheet-iron door and the coal continues to the end of the line where

it drops into a bin which supplies the railroad locomotives with their coal.

When the plant is in full operation the coal passes through the opening to a gravity bar screen with ½-inch spaces. The slack which passes through goes to the boiler house; the coal passing over this screen goes on to another bar screen with 1¼-inch spaces. The coal passing over this last screen goes to the lump-coal pocket, that going through falls on to a Fairmont pan conveyer which carries it to the head of a ¾-inch shaking screen. Coal passing through this screen goes to the slack pocket and that passing over runs into the nut-coal pocket.

The slack coal from the first bar screen runs into a scraper conveyer, which discharges into a boiler house conveyer 145 feet distant and at right angles to the line of the tipple. The second conveyer distributes the coal 75 feet through the boiler room. A 10-horsepower General Electric motor operates both conveyers.

From the tipple to the railroad cars the coal traverses a distance of about 300 feet along the mountain side and about 200 feet difference in elevation. The coal from the reciprocating feeder drops the coal into the retarding conveyer and it remains in the same position until it is discharged over the loading screens. There is no breakage or crushing apparent to the eye and the conveyer will handle 3,000 tons a day when the mines are fully developed. All the conveyers and their machinery were furnished by the Link-Belt Co.

It is in the buildings along the river at the tipple where the completeness of the entire plant is recognized. The four buildings are so completely equipped that it is possible to repair any part of the mine equipment and make almost anything that is needed save large castings.

The power house which is the largest building, and the only one south of the tipple, consists of boiler, engine, condenser, and pump compartments.

The boiler room contains two 300-horsepower batteries of Phoenix return tubular boilers with room for an additional battery when required. Underfeed stokers will soon be installed as well as an ash conveyer under the floor of the ash pits.

The engine compartment is on the same level with the boilers and contains two 500-kilowatt, Westinghouse-Parsons, 2,200-volt, 60-cycle, three-phase, turboalternators and one 200-kilowatt, Westinghouse, synchronous motor-generator set reducing 2,200-2,400-volt alternating current to 250-275-volt direct current. The motor-generator set is one of the two substations, the other being at Nos. 7 and 8 drifts of No. 2 mine.

The high-tension wires are tapped at the tipple with a bank of three single-phase step-down transformers which drop the current to 220 volts for use in the tipple motors. Owing to compressed air being used in the machine shops, a Sullivan cross-compound air-compressor has been installed. It is driven by a 50-horsepower induction motor.

The pump room is 11 feet below the floor of the boiler room and contains two 12″×7″×12″ American plunger boiler feed-pumps, equipped with Neco pump governors, two 8″×8″×12″ American piston pumps for water supply to the tank and one 1,000-horsepower Cochran feed-water heater.

The condenser room is 7½ feet lower than the pump room, or 18½ feet below the power-house floor, and contains Westinghouse Le Blanc condensers, with turbine pumps and one Marsh 5″×6″×10″ piston pump for auxiliary use.

The water supply is from the Allegheny River. A cribbing of white oak boards 8 feet high, 8 feet wide, and 32 feet long was first constructed. This cribbing was then sunk into the bottom of the river bed. It was covered over and around with clean stone and gravel, which acted as a filter. Two pipe lines, one 14-inch, and one 6-inch, were laid from this cribbing to the power house. The 6-inch line is connected to the Marsh pump for a reserve supply. The 14-inch line branches into three 8-inch lines inside of the power house. Two are connected with the condenser pumps and one is held in reserve for future extensions. Water is pumped through the condensers

Tipple, Screen House, Fuel Conveyer, and Power House

View from New Office toward No. 1 Drift

into the hotwell. The 8″ × 8″ × 12″ pumps take the water from the hotwell and discharge it into the railroad water tank outside the building for use of the railroad locomotives, and it is piped by gravity to the heater and the boiler-feed pumps for the power-house boilers. These pumps are equipped with Neco governors which automatically stop the pumps when the tank is full.

The buildings north of the tipple are the machine shop, foundry, and the wood working shop.

The machine shop is equipped with a 10-ton Shepard electric crane, a Jarecki pipe threading machine, 36-inch and 16-inch engine lathes, a 600-pound air hammer, a bull-dozer, a 42-inch radial drill, a Universal milling machine, a 24-inch shaper, and a punch and shears combined, all with individual motor drives. A sensitive drill, a centering machine, a cutter and tool grinder, an emery grinder, and a back saw, are driven from a line shaft.

The foundry at present contains a brass furnace, and core oven, with small tools. A 46-inch cupola with the necessary accouterments will be added in the spring.

The wood working shop is equipped with a 20-inch wood lathe, a 36-inch band saw, a Universal saw table, a swing saw, a wood boring machine, and a post borer, all of "Crescent" make.

Thus it is seen that this new operation has the facilities for meeting almost any contingency that may arise in the mining and handling of their coal.

All the buildings are of Hy-Rib construction with an 8-inch concrete wall as a base.

The town adjoining No. 1 mine is situated about half a mile back from the river near No. 5 and No. 6 drifts. The town is one of 70 houses with a water system similar to that at No. 2 mine. The towns contain a commissary which supplies the residents with all the articles available at any small department store.

It will be noted in the accompanying photographs that the tipple was constructed of wood instead of steel, as is the custom of most modern tipples. This was done owing to the abundance of timber available on the company's property. A saw mill is in operation and almost any sized piece of lumber desired can be turned out at small cost. The plant was planned and designed by the company's own engineers, at the Kittaning office.

Dwight C. Morgan, president of the company, is a man who is entirely in touch with all his employes and looks after their comfort and welfare with admirable keen sightedness for all details. It is due to his courtesy and to the cooperation of Fred Norman, Chief Engineer, that the writer was given every opportunity of inspecting this new and complete plant.

The Porcupine Column-Pipe Cleaner

The Philadelphia & Reading Coal and Iron Co., has adopted a simple device for use in the removal of the accumulations of mud, rust, etc., from the interior of the column pipes at their collieries in the Mahanoy Valley, Schuylkill County, Pa.

The device, which we call the "Porcupine" column-pipe cleaner, on account of its peculiar appearance, can be made at any mine at a trivial cost. It consists of a ball of hard wood, cut to a diameter suited to the pipe it is to clean. Its diameter should vary from 1½ inches for a 4-inch pipe, to 4 or 5 inches for a 10-inch pipe, etc. Numerous pieces of ¼-inch square steel rods are driven into the ball toward its center, and allowing from 1 inch to 2 inches of the rods to project from the surface of the ball, according to its size. The rods are cut as shown in *a*, Fig. 1; that is, pointed at one end and the projecting end filed to a chisel edge.

A section of the ball would disclose an arrangement like *b*, Fig. 1. It is noticed that the tips of the rods form a sphere of a diameter larger than the ball by twice the length of the projecting wires, see *c*, Fig. 1.

The cleaner is dropped into the column pipe when the pump is at rest and owing to the weight of the heavy wood and the steel bits, it sinks to the bottom of the column. When the pump is started it is forced upward with a rotary motion and the chisel-shaped quills or bits cut the scale from the inside of the pipe. Sometimes this is accomplished by using the cleaner but once, and other times it requires

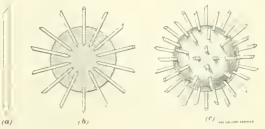


Fig. 1. Column Pipe Cleaner

several trips up the column to do the work, but it does it effectually. After the cleaner has been placed in the column a wire basket is attached at the mouth so as to catch it as it emerges from the pipe.

The size of the cleaner, that is, the diameter from tip to tip, must necessarily be from 1 inch, in case of small columns, to 3 inches in the larger ones, smaller than the column.

Spitzbergen Coal

Longyear City is situated about latitude 78° North on Advent Bay, Spitzbergen. This northernmost town on the map owes its establishment to an American company mining coal there, and has added interest because it was too cold a country for cold-enduring Eskimos to inhabit. The coal beds are said to be fairly horizontal, about 300 feet above sea level. An English company first started mining at Advent City across the bay from Longyear, but they did not carry on operations very long. The Arctic Coal Co. employs 200 miners, mostly Scandinavians, at Longyear City. Farther north, in latitude 79°, an American concern, the Northern Exploration Co., operates coal mines and marble quarries. According to statements of employes, the coal mine walls are entirely white on account of the ice crystals.

Electric Mine Haulage

Determining Haulage Capacity of Locomotives—Overhead and Track Construction—Operating Troubles—Costs of Mine Haulage

By Eric A. Lof* (Concluded from December)

LOCAL conditions must be given a very careful study in laying out a system of electric mine haulage. Not only should the present output be considered but also the possibilities of increased output and longer hauls. The number of cars to be handled per trip and per hour, the time of lay-over, etc., must be correctly determined so as to result in the most efficient operation. It is also important that the main-haul locomotives have sufficient capacity to place on the parting enough empty cars per trip to serve the gathering locomotives simultaneously in order to prevent any reduction in the output from delays.

The amount of load which a locomotive is capable of hauling depends on the weight of the locomotive, the adhesion between the driving wheels and the track, the frictional resistance of the trailing load, and the curvature and gradients of the track.

Adhesion.—This varies greatly, depending on the condition of the surfaces in contact, but experience has shown that with clean dry rails on a level track the coefficient of adhesion can safely be assumed to be 20 per cent. for cast-iron wheels and about 25 per cent. for steel-tired wheels. A 10-ton locomotive with steel-tired wheels, for example, would therefore develop on a straight level track a maximum tractive effort of $10 \times 2{,}000 \times .25 = 5{,}000$ pounds, before slipping the wheels.

With wet and slippery rails, when starting heavy trains or on steep grades, sand is used to increase the adhesion, which by this means may be increased to about 25 to 30 per cent. for cast-iron wheels and 30 to 33⅓ per cent. for steel-tired wheels. Due to excessive wear of wheels and other undesirable effects when sand is used too freely, it should be limited in application to starting heavy trips and climbing the steepest grades. It is therefore not advisable to load a locomotive to its maximum tractive effort continuously, but about 10 or 15 per cent. reserve capacity should preferably be left.

Acceleration and Retardation. Only moderate acceleration and retardation are as a rule required in mine haulage service, .2 mile per hour per second being a sufficient value. This corresponds to a force of about 20 pounds per gross ton of the combined load and locomotive. This factor, however, is usually neglected unless the train is to be started on a grade, as the slack can be taken up at the several couplings and thus only one car at a time is actually started. Quite steep grades exist also in the majority of cases, and the increased capacity of the locomotive to take care of these is usually greater than the percentage increase in weight of the locomotive demanded due to acceleration.

Where the service demands a high rate of acceleration the weight of the locomotive must be increased accordingly. The unit of acceleration is generally taken as 1 mile per hour per second, and the force required to accomplish this is about 95 pounds per ton above the frictional resistance.

Frictional Load Resistance.—This is caused by the friction of the wheel treads and flanges against the rails and by the friction of the car journals. It may be as low as 10 pounds per ton or as high as 60 pounds, depending on the nature and condition of the bearings, the size of rails, etc. For narrow-gauge roads with light rails and ordinary mine cars, from 20 to 30 pounds per ton is a fair figure.

For the locomotives, a resistance of from 12 to 15 pounds per ton is quite common, but this is generally such a small percentage of the total tractive effort that it can be neglected.

Curves.—The resistance of curves can as a rule be neglected, unless they are very long or have a short radius. It is desirable, therefore, to lay out curves to as large a radius as local conditions will permit, and ordinarily the radius of the sharpest curve should not be less than five or six times the wheel base.

The number of pounds per ton to be added for curve resistance is about .5 pound per ton per degree, while for short curves with the gauge spread it may be about .3. Curves are generally designated by their radii in mining work, although sometimes they are given in degrees; the number of degrees of a central angle subtended by a cord 100 feet long being specified. The value of a curve in degrees can be obtained by dividing 5,730 by the radius of the curve in feet.

Ordinarily, only a portion of the train will be on a curve at one time, so that the draw-bar pull to be added should only be based on the actual number of cars which are placed on the curve at one time.

Grades.—Many grades in mining work are so short that only a part of the trip can occupy the up grade at one time, the balance of the trip being on a lesser grade, on level, or on a down grade. By accelerating to a high speed as the hill is approached, quite steep grades of short length may be mounted without difficulty, and in such cases the locomotive can be worked close to the slipping point.

The resistance due to grades is always 20 pounds per ton for each per cent. grade, and not only does a grade greatly increase the total train resistance, but it also reduces the available draw-bar pull of the locomotive, for of the total tractive effort developed at the drivers, 20 pounds per ton for each 1 per cent. grade is consumed solely in driving the locomotive itself up the grade.

The size of a locomotive for a given load is therefore principally determined by the limiting grade. For example, assume a trailing load of 80 tons, a frictional car and track resistance of 20 pounds per ton, and a track that is practically level

*Schenectady, N. Y.

throughout with the exception of a stretch of 2 per cent. grade. The total train resistance on the level portion of the track is $80 \times 20 = 1{,}600$ pounds, but on the grade it is 80 $(20 + 2 \times 20) = 4{,}800$ pounds, and in addition the force required for propelling the locomotive up the grade. A 4- or 5-ton locomotive could easily handle this on the level, while a 13- or 14-ton locomotive would be required to get it over the grade.

Motor Equipment.—Motors for mine locomotives are generally rated on the 1-hour basis, i. e., the load which it will carry continuously for 1 hour without exceeding a certain specified temperature, usually 75° C. Standard equipments are furthermore so selected that the motors will develop the rated draw-bar pull and speed of the locomotive on the above basis. Short overloads of 15 or 20 per cent. can generally be taken care of, while at overloads of about 25 per cent. the wheels will begin to slip.

The 1-hour rating of a motor depends largely upon the terminal capacity, while the real capacity is its ability to perform its cycle of operations during the entire day. The selection of the proper motor equipment on this basis, after its weight has been decided upon, involves a complete knowledge of the profile of the road, the number of cars to be handled per trip and per hour, the weight of the empty and loaded cars and the frictional resistance. The motor capacity depends upon the temperature which the windings will attain, and this in turn upon the average heating value of the current. Since this is proportional to the square of the current value, the average heating for an all-day service must be determined from the square root of the mean square of the current.

A motor is selected from the various sizes which will fit the locomotive in question, and from the above data and the characteristics of this motor equipment, the current and speed are obtained for each part of the cycle. The current values are then squared and multiplied with the time during which they last. To allow for the extra heating produced by the acceleration and the switching and making up of trips at the ends of the run, about 10 per cent. should be added to the sum of the time-current-squared values for fairly long runs and about 15 per cent. for short runs. The sum of all these values is then divided with the total time, including lay-overs, the result being the average squared current value. By taking the square root of this value the root-mean-squared value of the current for the complete cycle is obtained. If the continuous capacity of the motor selected is below this value, a larger motor must be selected. Since the motor curves usually give values for one motor, the locomotive and trailing weights, etc., should naturally be divided by two to give the weight each motor will be required to handle.

The tendency to use larger motors than formerly is quite common and is justified largely by the lower maintenance cost, but this can be carried too far, especially in small mines where the cycle of duty is such that the motors could not be overheated. In large mines, and especially for the long main haulage duties, a careful comparison of the required duty and the motor characteristics should be made to insure a safe motor temperature. An approximate rule, easy to remember, is that a total motor capacity of about 10 horsepower is required for every ton the locomotive weighs.

Trolleys, Feeders, and Rails.—Current is generally fed to the locomotives through an overhead trolley system with the track rails forming the return circuit. In addition to the trolley wire, it is also almost always necessary to install feeders so as to reduce the voltage drop. These consist of heavy cable run alongside the trolley wire on the walls in the entries and tapped into the trolley wire at intervals along the route.

TABLE 2. WEIGHTS AND CAPACITIES OF COLLIERY CARS. FOUR WHEELS, USUAL GAUGE 35 INCHES TO 44 INCHES

Approximate Capacity. Bushels, Run of Mine Coal	Weight of Empty Car Pounds	Average Weight of Load Bituminous Coal Pounds
15	500	1,200
20	606	1,500
25	850	1,900
30	950	2,300
33	1,050	2,500
35	1,150	2,700
40	1,250	3,000
46	1,400	3,500
54	1,700	4,100
Long Tons of Coal		Anthracite
2½	2,000	5,700
3	2,500	6,700

TABLE 3. MISCELLANEOUS DATA

A bushel of bituminous coal weighs 76 pounds.
A bushel of hard coke weighs 40 pounds.
One ton, 2,000 pounds, of bituminous coal requires for storage 40 cubic feet.
One ton, 2,240 pounds, of bituminous coal requires for storage 45 cubic feet.
One ton, 2,000 pounds, of anthracite requires for storage 33 cubic feet.
One ton, 2,240 pounds, of anthracite requires for storage 37 cubic feet.
A cubic yard of loose earth weighs 2,200 to 2,600 pounds.
A cubic yard of loose rock weighs 2,600 to 3,000 pounds.
Horsepower exerted by an electric locomotive $= \frac{D \; B \; P \text{ in lb.} \times \text{speed in } M \; P \; H}{375}$ and is approximately equal to kilowatt input.

In the early days of electric mine haulage the size of trolley wire was much smaller than now used, the size varying from No. 0 to No. 0000. The former is only used in small one- or two-locomotive installations, and experience has shown that a heavy trolley wire is of considerable advantage. For this reason the use of No. 0000 trolley wire is now very common.

The size of the feeders depends on the length of the haul, the distribu-

TABLE 1. STANDARD ELECTRIC LOCOMOTIVES

Weight in Tons (2,000 Pounds)	Rated D. B. P. in Pounds Level Track	Maximum Tractive Effort in Pounds	Speed at Rated D. B. P. in Miles Per Hour		Approximate Kilowatt Input at Rated D. B. P. and Speed	Minimum Radius of Curve in Feet
			Motors in Series	Motors in Parallel		
4	1,600	2,000	2.5	6.2	26	18
5	2,000	2,500	3.0	6.7	35	22
6	2,400	3,000	3.5	7.8	50	22
7	2,800	3,500	3.2	7.6	55	22
8	3,200	4,000	3.2	8.0	65	23
10	4,000	5,000	3.8	8.2	80	30
12	4,800	6,000	3.6	7.8	93	30
13	5,200	6,500	3.5	7.7	100	30
15	6,000	7,500	3.2	7.1	115	30

tion of the load, the current to be transmitted and the permissible voltage drop. Excessive drop is a very common cause for complaint in a mine using electric haulage and it always pays to put sufficient copper in the feeders to prevent the voltage at the locomotives from falling to too low a value. Low line voltage makes it difficult to maintain the schedule and gives rise to trouble with the motors, to say nothing of the cost of the power loss. As approximate rule, the voltage drop from the point of supply to any locomotive should be kept within 20 per cent.

As the rails form the return circuit for the electric current, it follows that they must necessarily be considered in connection with the voltage drop. The rail itself, on account of its large cross-section, has a large current carrying capacity and the bonding should be done so that no appreciable drop will take place in the joints. The weight of rail in pounds per yard is fixed by traffic considerations and is usually determined by allowing 10 pounds per yard for each ton of locomotive weight per driving wheel. Thus, a 10-ton, four-wheel locomotive would have $\frac{10}{4}=2.5$ tons per driver and the required weight of rail would be $2.5\times10=25$ pounds per yard. This formula gives the minimum weight of rail, but much better results will be obtained by using the heavier rail recommended in Table 4.

The resistance of steel rails to the passage of an electric current varies considerably with the composition of the metal. For the purpose of calculation it is, however, common to take the specific resistance of steel rails as 12 times that of copper. While this value may seem somewhat high, it is conservative and will allow for the slight additional resistance at the joints. By using the values from Table 5, the rails can therefore be considered as continuous.

The resistance values given are for two rails in parallel, i. e., per mile of track.

TABLE 5. RESISTANCE OF STEEL RAILS

Weight of Rail Per Yard	Resistance in Ohms Per Mile of Track
16	.1642
20	.1313
25	.1051
30	.0876
40	.0657
45	.0583
50	.0525
60	.0438
80	.0328

The above values are based on the following formula:

$$\text{Ohms per mile}=\frac{2.63}{\text{Weight of rail per yard}}$$

An approximate estimate of what the drop in the rails will be can easily be formed at the outset. The balance of the drop will then give that allowed for the trolley and feeders combined, and their cross-section can be determined from the following formula:

$$\text{Area in circular mills}=\frac{10.8\times L\times I}{D}$$

in which

L = distance between point of supply and load in feet;

I = maximum current in amperes;

D = volts drop in trolley and feeders.

From the value so found is subtracted the cross-section of the trolley in circular mils, the result being the required size of the feeders. The calculation is easy, the only difficulty being the variation in the load both in magnitude and position.

In order to illustrate the method of calculation assume the following example:

CASE 1.—Voltage, 500; rails, 40 pounds; trolley, No. 0000; length of road, 1 mile; load, 400 kilowatts, bunched at end of line; permissible drop, 20 per cent. = 100 volts.

Find the size of feeder.

Resistance of 1 mile of two 40-pound rails = .0657.

$$\text{Current}=\frac{400{,}000}{500}=800 \text{ amperes.}$$

Drop in rails $=800\times.0657=52.6$ volts.

This leaves a drop of $100-52.6=47.4$ to take place in the trolley wire and feeder. Assuming the same conductivity of the material in these, their combined cross-section should be:

$$\text{C.M.}=\frac{10.8\times5{,}280\times800}{47.4}=965{,}000.$$

The trolley wire is No. 0000 and has a cross-section of 211,600 C. M. Deducting this from the total cross-section of 965,000, leaves $965{,}000-211{,}600=753{,}400$ or about 750,000 C. M.

CASE 2.—Suppose now that the total load of 400 kilowatts is equally distributed. This is equivalent to an average load of 200 kilowatts transmitted over the whole circuit. The drop in the rails is now only half the former value or 26.3 volts, leaving $100-26.3$ or 73.7 volts to be consumed in the trolley and feeders. Their combined cross-section will therefore be: C. M.

$$=\frac{10.8\times5{,}280\times400}{73.7}=310{,}000 \text{ C. M}$$

TABLE 4. SIZES OF LOCOMOTIVES AND RAILS

Weight of Locomotive in Tons	Minimum Weight of Rail Per Yard and Size of Bond		Weight of Rail Per Yard Recommended and Size of Bond	
	Rail	Bond	Rail	Bond
		Number		Number
3	16	4	20	0
4	16	4	25	0
5	16	4	25	0
6	16	4	30	0
7	20	0	40	00
8	20	0	40	00
10	25	0	45	00
15	40	00	50	0000
20	50	0000	60	0000
25	60	0000	80	0000

TABLE 6. COPPER CONDUCTORS. DIMENSIONS, WEIGHT, RESISTANCE, AND CARRYING CAPACITY

No. B. & S. Gauge	Area Circumference Mils	Diameter in Mils Bare	Weight in Pounds		Resistance		Safe Current Carrying Capacity Amperes
			1,000 Feet	Mile	1,000 Feet	Mile	
	500,000	819	1,525	8,052	.0207	.1093	590
	400,000	728	1,220	6,442	.0259	.1366	500
	350,000	679	1,068	5,636	.0296	.1562	460
	300,000	630	915	4,831	.0345	.1822	400
	250,000	590	762	4,026	.0414	.2186	355
0000	211,600	460	640	3,381	.0489	.2583	312
000	167,800	410	508	2,682	.0617	.3258	262
00	133,100	355	403	2,127	.0778	.4108	220
0	105,500	325	320	1,687	.0981	.5180	185
1	83,690	290	253	1,337	.1237	.6531	156
2	66,370	258	201	1,062	.1560	.8237	131
3	52,630	230	160	841	.1967	1.0386	110
4	31,740	205	127	667	.2480	1.3094	92
5	33,100	182	100	529	.3128	1.6516	77
6	26,250	162	80	420	.3944	2.0824	65

Deducting from this 211,600 C. M. for the trolley leaves only about 100,000 C. M., which corresponds to No. 0 feeder.

In making the above calculations attention must also be paid to the carrying capacity of the wires and cables. This must be kept in mind, because if the lines are simply figured out on the basis of giving the allowable drop, it might happen that the current will be sufficient to overheat the wires. In most cases, however, it will be found that the size of wire necessary to keep the drop within the specified limits will be considerably larger than necessary to handle the current without overheating. It is always well, however, to compare the sizes obtained and the current carrying capacity, which will be found in the wire table.

By referring to the example it is seen that in Case 1 there is no danger of overheating, but for Case 2 it will become necessary to increase the size considerably in the section nearest the station where the current value is too high.

The pressure at which the current is supplied to the cars is limited by considerations of safety. It would otherwise, of course, be desirable to use a higher pressure, because this would mean a lower current, less drop and smaller feeders for the same power. For this reason 500 volts is used in a few mine haulage systems, although 250 volts evidently is somewhat safer in operating.

In mines of ordinary capacity it will be uneconomical to use the direct-current system only, when the current has to be transmitted for distances over a mile, and many mines have during the last few years been changing over their systems to a combination alternating current and direct current. That is, alternating current is generated and transmitted at a higher voltage to substations distributed along the tracks. In these substations the alternating current is changed to direct current by means of synchronous converters. In this manner the 250-volt, direct-current supply can be brought near the centers of distribution and the losses in the lines, feeders, and rails are considerably reduced, also smaller size conductors can be used.

Table 7 can be used in making approximate estimates for the sizes of wires for three-phase transmission service, as in the following example:

Required: The size of wires to deliver 500 kilowatts at 6,000 volts, at the end of a three-phase line 12 miles long, allowing energy loss of 10 per cent. and a power factor of 85 per cent. If the example called for the transmission of 100 kilowatts (on which the table is based), look in the 6,000-volt column for the nearest figure to the given distance, and take the size wire corresponding. But the example calls for the transmission of five times this amount of power, and the size of wire varies directly as the distance which in this case is 12 miles. Therefore, we look for the product $5 \times 12 = 60$ in the 6,000-volt column of the table. The nearest value is 60.44 and the size wire corresponding is No. 00, which is, therefore, the size capable of transmitting 100 kilowatts over a line 60.44 miles long, or 500 kilowatts over a line 12 miles long as required by the example.

If it is desired to ascertain the size wires which will give an energy loss of 5 per cent., or one-half the loss for which the table is computed, it is only necessary to multiply the value obtained by 2, since the diameter varies directly as the per cent. energy loss.

Distance to which 100-kilowatt, three-phase current can be transmitted over different sizes of wires at different potentials, assuming an energy loss of 10 per cent. and a power factor of 85 per cent. is shown by Table 7.

Table 7

No. B. & S.	Area in Circular Mils	Distance of Transmission for Various Potentials at Receiving End								
		2,000	3,000	4,000	5,000	6,000	8,000	10,000	12,000	15,000
6	26,250	1.32	2.98	5.28	8.27	11.92	21.12	33.1	47.68	74.50
5	33,100	1.66	3.75	6.64	10.40	15.00	26.56	41.6	60.00	93.75
4	41,740	2.10	4.74	8.40	13.15	18.96	33.60	52.6	75.84	118.50
3	52,630	2.54	5.96	10.16	16.55	23.84	40.64	66.2	95.36	149.00
2	66,370	3.33	7.51	13.32	20.85	30.04	53.28	83.4	120.16	187.75
1	83,690	4.21	9.48	16.84	26.32	37.92	67.36	105.3	151.68	212.00
0	105,500	5.29	11.92	21.16	33.10	47.68	84.64	132.4	191.72	298.00
00	133,100	6.71	15.11	26.84	41.97	60.44	107.36	167.9	241.76	377.75
000	167,800	8.45	19.04	33.80	52.85	76.16	135.20	211.4	304.64	476.00
0000	211,600	10.62	23.92	42.48	66.42	95.68	169.92	265.7	382.72	598.00

Table 8.—Voltages Advisable for Lines of Various Lengths
(Three-Phase Transmission)

Length of Line	Voltage
Up to 1 mile	500 to 1,000
1 to 2	1,000 to 2,300
2 to 3	2,300 to 6,600
3 to 10	6,600 to 13,200
10 to 15	13,200 to 22,000
15 to 20	22,000 to 33,000

Operating Hints.—Before an electric mining locomotive is put into service, it should be inspected to see that all parts are in proper condition. It should be well oiled and the sand boxes should contain plenty of dry sand. The sand levers and brakes should be tried to see that they are operating satisfactorily, and the controller should be on the "off" position before the trolley pole is put on.

When starting the locomotive, throw the current on gradually and pay due consideration to the load which the locomotive is called on to haul. The slack in the couplings will often relieve the starting condition so that it will not be necessary to start all the cars in the train simultaneously. In advancing the controller from one notch to another, do it quickly, allowing it to remain at this point until the locomotive has gathered speed to correspond, when it should again be moved quickly to the next notch, etc. If, however, the controller has been advanced too rapidly and the wheels begin to slip, do not move the controller backwards one or two steps but throw it quickly completely "off" and advance it again in the usual manner. If the control is moved backwards slowly, arcing at the contact fingers may cause burning and blistering.

The controller is only intended for starting duty and the locomotive should not be run continuously with the controller on intermediate position, as this is liable to cause a burn-

out of the resistance or other damage to the controller.

If the locomotive runs too fast with the controller in the "on" position and the motors in parallel, put the motors in series or throw the current "on" for a short time, then "off," letting the locomotive coast.

When it is necessary to brake, the controller should first be thrown to the "off" position before the brakes are applied. The controller should not be used for braking, by reversing the motors, unless in case of emergency. This practice is sometimes resorted to, but is very severe on the motors, controllers, and in fact on the entire equipment. Reversing the motors when running at full speed is apt to break the gears and spring the armature shaft.

OPERATING TROUBLES

Failure to Start.—The most common cause of a motor failing to start is broken connection in the electric circuit in the motors, the trolley, the track return, the circuit breaker, controller, or resistance grids. If the open circuit is in the motors, the defective machine can be located by raising the brushes of each motor commutator successively, with the controller in the multiple position and the current applied. If, however, it is found that neither of the motors will operate so connected, it shows that the opening is in some other part of the electric circuit than the motors. An examination to determine this, is best made by the use of a bank of lamps, one end of which is connected to the trolley wire and the other end applied to different parts of the circuit beginning with the trolley harps and taking the circuit step by step until the open circuit is passed.

When the open circuit is found to be in the field coils in one of the motors, it becomes necessary to cut this motor out of circuit and drive the locomotive with the other motor. Only half of the customary load should then be hauled although the locomotive will to a great extent protect itself, as the wheels connected to the driving motor will have a tendency to slip, which of course will determine the amount of load that the locomotive is capable of hauling. The defective motor is best cut out by removing its brushes.

Failure to start may also be due to faulty connections causing the motors to buck each other. This will cause a heavy current and the fuse or circuit breaker will blow. It is readily corrected by reversing the brush leads on one motor. Grounding the current may also prevent a locomotive from starting, while on the other hand mechanical troubles are often the cause; for example, the brakes may not be released, the gears may be broken, the bearings stuck or seized, etc.

If the locomotive jumps or does not start up smoothly, this is generally caused by short circuits in the starting resistance, wrong or open connections, controller troubles, etc.

Excessive Heating.—Heating may be due to the motors being overloaded when hauling heavy trips, and can then only be remedied by reducing the load or by providing larger locomotives.

Low voltage is a very common cause of a motor not developing its rated load, causing overheating due to slower speed, breakdowns, etc. This may be the result of insufficient copper in the overhead wires, poor bonding of the rails, poor connections in the circuit or insufficient prime mover or generator capacity.

A short circuit in any armature turn will cause a circulation of heavy current therein, followed by excessive heating. This current is due to the transformer action of the field coils acting as primary and the short circuited armature turns as secondary. The trouble can generally be detected by the smell of burning insulation or by the hand, as the short circuited coils will be much warmer than the other part of the armature. As a temporary remedy the short circuited coils can be open circuited at the commutator and disconnected from it, the commutator being bridged at this point to close the gap.

Short circuited field turns will cause the motor to speed up, particularly at light loads. This tendency to speed up will cause the motor to take an excessive current, causing overheating of the defective motor armature. The defective coil can be located by feeling with the hand, as it will be much cooler than the others. This is due to the reduced number of turns, which decreases the resistance of the coil and consequently the amount of loss therein. When a field coil is found to be short circuited so as to affect the operation of the motor, the coil should be removed and replaced by a new one.

Burn-out caused by excessive heating is also caused by the armature coming down on the pole faces. The remedy for this is, of course, only to give more attention to the motor bearings, keeping them properly lubricated and by frequently checking the air gap to see if the armature is getting dangerously close to the pole faces.

Sparking.—Excessive sparking at the brushes is frequently caused by an open circuit in the armature winding. Such sparking may often become so violent as to cause the motors to flash over at the commutator. On examination it will be found that the commutator segments, between which the open circuit occurs, are blackened and slightly burned. If the open circuit is not taken care of at once it is liable to cause a flat spot on the commutator, requiring turning. Temporary relief can be had by bridging the open circuit at the commutator.

Short circuited field turns, if it affects a large number of turns, is also liable to cause excessive sparking at the brushes.

Commutator troubles are a very common cause of sparking, and commutators should be kept free from oil and dirt. If they become very rough due to overheating and excessive sparking it may be necessary to smooth them with sandpaper, and if this does not help, returning is the remedy.

Trouble with the commutators is often due to careless handling of the locomotive, such as operating the locomotive with a defective con-

troller or a defective resistance. When a resistance is found to have a broken grid a new grid should be put in at once. The method sometimes resorted to of short circuiting a broken grid should not be allowed, except for temporary work, for when doing so, a large per cent. of the resistance may be cut out of one or more of the steps, causing the motors to take excessive current when this point on the controller is reached. This will cause the locomotive to start with a jerk and very likely burn the commutator and brushes, besides being hard on the gears and other mechanical parts of the locomotive.

Grounds.—When a ground occurs in a motor, whether it is confined to the armature, field coils, or commutator, it will cause the breaker or fuse to blow, and it will not be possible to keep the breaker closed without holding it in, which should never be done.

Motors will also sometimes show a ground when tested with a voltmeter or a bank of test lamps, but otherwise will operate satisfactorily. It is then evident that there is a leakage path formed somewhere, and if the motors are not inspected and thoroughly cleaned to remove this partial ground it is only a short time before a permanent ground can be expected.

When a ground occurs the motor containing it should be cut out of service and the locomotive operated by the other motor until such time as the ground can be located and remedied.

COST OF MINE HAULAGE

It is extremely difficult to obtain correct figures showing the cost of mine haulage, and when found they are of little value, as the conditions vary widely in different mines. For instance, in one mine the grades may be in favor of the loaded cars, while in another the conditions may be unfavorable.

The following costs, taken from a paper presented by F. Tillman, at the International Mining Congress in Dusseldorf, 1910, will, however, serve to approximately illustrate the comparative operating costs per ton-mile of different mine haulage systems. In making the comparison it must, however, be remembered that this refers to European conditions where labor can be obtained at considerably lower rates than in this country. The difference in hauling capacity must necessarily also be kept in mind; especially for the first system, where the hauls are longer and the loads larger than in the other. This is undoubtedly the reason for the low cost per ton-mile of this particular installation.

ELECTRIC TROLLEY LOCOMOTIVES

Capacity, 2,530 tons per day in two 8-hour shifts.
Haulage distance, 3.75 miles.
Speed, 7½ miles per hour.

Cost of equipment, covering four locomotives (including one reserve) of 112-horsepower capacity each, converter station and overhead construction	$53,500
Yearly Operating Costs	
Interest and amortization	$ 5,350
Maintenance of converter station and locomotives	2,580
Maintenance of overhead work	1,770
Labor	5,850
Energy: 575,264 kilowatt-hours	8,250
Oil and waste	1,600
Total	$25,350

Cost per ton-mile, based on an output of 2,830,000 tons-miles per year = $\frac{25,350}{2,830,000}$ = $.009.

STORAGE BATTERY LOCOMOTIVES

Capacity, 2,400 tons per day in two 8-hour shifts.
Haulage distance, .7 mile.
Speed, 6½ miles per hour.

Cost of equipment: Five 20-horsepower (one reserve), converters, switchboards, etc.	$14,250
Storage batteries	10,000
Cable and buildings for converter stations	7,400
Total	$31,650
Yearly Operating Costs	
Amortization of locomotives, converters, and switchboards	$ 1,425
Battery renewals	1,400
Interest	970
Labor	7,000
Maintenance	560
Energy: 184,349 kilowatt-hours	1,755
Oil and waste	135
Acid and distilled water	350
Total	$13,595

Cost per ton-mile, based on an output of 375,000 tons-miles per year = $\frac{13,595}{375,000}$ = $.036.

BENZINE LOCOMOTIVES

Capacity, 1,252 tons per day in two 8-hour shifts.
Haulage distance, .55 mile.
Speed, 4 to 6 miles per hour.

Cost of equipment: Four locomotives (including one reserve) of 8-horsepower capacity. Building for housing locomotives	$8,700
Monthly operating expenses:	
Interest and amortization	$ 85
Locomotive maintenance	175
Labor	200
Benzine (4,750 pounds)	95
Oil and waste	20
Total	$575

Cost per ton-mile, based on an output of 18,000 tons-miles per month = $\frac{575}{18,000}$ = $.032.

COMPRESSED AIR LOCOMOTIVES

Capacity, 2,000 tons per day in two 8-hour shifts.
Haulage distance, .6 mile.

Cost of equipment: Four 12-horsepower locomotives (one reserve), compressor installation, etc.	$14,250
Yearly operating expenses:	
Interest and amortization	$1,425
Oil, waste, and maintenance	600
Labor	3,000
Energy (170 horsepower for 300 days, 16 hours per day)	3,875
Total	$8,900

Cost per ton-mile based on 370,000 ton-miles per year = $\frac{8,900}{370,000}$ = $.024.

The above figures clearly show the great savings which can be accomplished with the electric system of mine haulage, and when considered together with the other advantages, outlined in the beginning of this article, the superiority of this system over any other cannot be disputed.

The author wishes to express his appreciation to Mr. C. W. Larson for his kindness in offering many valuable suggestions in connection with the preparation of this article.

Water Softeners

The Crozier Coal and Coke Co., which operates mines in the Pocahontas field at Elkhorn, W. Va., has installed water softeners to protect the stomachs of its employes and the boilers in the power house. One of the two softeners has a capacity of 15,000 gallons per hour; the other, 5,000 gallons per hour.

The softener consists of a vertical steel cylinder into one side of which the water from the deep well flows, over an overshot wheel that operates the mechanism which measures out a certain quantity of lime and soda ash to be mixed with a measured quantity of water. The chemicals are stirred in the water by revolving blades until every drop is brought in contact with the lime and soda ash. The chemicals coagulate the impurities in the water so that they will sink quickly to the bottom. As soon as the water flows into the settling compartment the purified water rises to the top where it flows out through a wooden filter in the service pipes. The only attention required for these softeners is to put in a charge of softening material once a day and to remove the sludge by opening a valve a few seconds.

The cost of the smaller softener, including the house and foundations, was $3,250, while the larger one cost $5,300. The cost of softening the water varies from 2.3 cents to 3.5 cents per thousand gallons. An average price for high-grade lime is $4.50 a ton. Soda ash in bags of 3,00 pounds in carload lots costs about $20 a ton.

Testing for Firedamp With Wire Loop

Further Results of Gas-Testing Experiments, Showing the Action of the Loop on the Flame and the Reasons for It

By Henry Briggs, M. Sc., A. R. S. M.*

IN THE March issue of THE COLLIERY ENGINEER an abstract was given of the writer's paper on the "loop" gas testing device. The original paper† was read before the Mining Institute of Scotland in February, 1912, and since then a controversy which shows no signs of diminishing vigor has raged over this simple piece of twisted wire. It is doubtful, indeed, whether any special gas testing device has ever received so searching a criticism, and perhaps it may be claimed as a point in its favor that it has so far weathered the storm. American readers may be interested in the results of continued experiments with the device.

The Loop.—The device consists of a piece of 22-gauge wire, bent in the form of a loop whose longer axis is equal to the width of the wick of any ordinary safety lamp. It is supported on an upright brass stalk extending through the oil vessel of the lamp, as shown in Figs. 1 and 2, and by turning the stalk the loop can be swung into the flame, which is kept of normal or working height. The mode of support allows of a small vertical adjustment. The method of using the loop for firedamp testing is described on page 440 of the March issue. The lamp man should be instructed to turn the loop into the "on" position before screwing the lamp bottom in or out. This prevents any chance of the wire being bent in the operation.

Action of the Loop on the Flame. When adjusted in the flame the loop has the power of deluminating it, and of converting it into a blue flame not unlike that of alcohol. The advantages of this for gas testing purposes are sufficiently apparent. The reason for the delumination is a twofold one. The luminosity of a safety-lamp flame is due to the presence of minute incandescent carbon particles, set free by the decomposition of the hydrocarbons of the oil or spirit the lamp is using. The loop in the first place conducts away a portion of the heat and cools the particles to a temperature below that of incandescence; it also alters the process of decomposition of the oil or spirit in such a way as largely to prevent the formation of those particles. This last result is due to Professor Smithells. of Leeds University, who has shown the whole structure of the flame to be altered by the insertion of the wire.

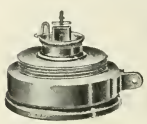


FIG. 1

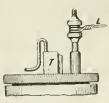


FIG. 2

Character of the Lamp Fuel.—In Britain things are slowly moving toward the abandonment of colza-paraffin mixtures for safety lamps, and especially for officers' lamps. It is becoming commonly known that spirits, such as benzolene and naphtha, not only allow of smaller gas percentages being revealed by the lowered flame, but that they possess the enormous advantage over a colza mixture of not charring the wick. While it is true that the loop method is not affected to the same degree by a badly crusted wick as is the ordinary method of gas testing with the lowered flame, yet experience underground has shown that there is difficulty in getting satisfactory results after a lamp burning colza and paraffin has been in use 2 or 3 hours. For this reason the writer has given up using colza mixtures along with the loop, and advises the adoption of one of the common lamp spirits instead.

The Fuel Cap.—When a spirit flame is lowered in pure air until all white light disappears, a blue cap—sometimes visible entirely and sometimes only partially—is seen above the flame. The name "fuel cap" is generally used for this halo. Those skilled in gas testing are aware of its presence, and, in order not to be deceived by it, accustom themselves to the appearance of the test flame in fresh air. Unfortunately the fuel cap cannot always be taken into account, as it is not of constant intensity; it is least apparent when the lamp is cool and most apparent when hot. Usually it is assumed that the fuel cap is due to vapor rising up the wick tube from the spirit receptacle below, the vapor being produced by the heat of the lamp. While there is no doubt that such volatilization takes place in a hot lamp, and that the vapor of the spirit increases the intensity of the cap, the writer particularly wishes to point out that the fuel cap is not actually formed by such means, and that, indeed, it is an intrinsic part of a hydrocarbon flame. It is not necessary for the fuel to be liquid in order to give this halo. A very distinct fuel cap may be witnessed by setting fire to a piece of string in the dark. It will then be observed that the flame is composed of three sharply defined parts: First, there is the inner, luminous kernel; second, a green fringe or mantle surrounding that kernel, and, third, the ghostly blue fuel cap which is most visible when the flame is on the point of extinction. The same phenomenon is to be seen with an ordinary gas flame turned very low, and particularly with an acetylene flame. Yet neither with the string nor gas flames can the fuel cap be due to volatilization taking place outside the flame.

When firedamp is present, this cap becomes a more important member of the flame. With the lowered flame of a lamp burning a spirit, quantities of the gas less than 1 per cent. have little power in extending

*Head of the Mining Department, Heriot-Watt College, Edinburgh, Scotland.

†Transactions Institute Mining Engineers, Vol. XLIII, page 64.

the height of the initial cap; their effect is chiefly to make it more luminous. With less than about three-fourths per cent. of firedamp, however, the difference is not sufficiently marked to permit even a well-trained observer to estimate the percentage of gas with anything approaching exactitude under working conditions. A heavy oil like colza possesses an initial cap which is both shorter and less intense than that given by a spirit such as naphtha; indeed, with the size of lowered flame usually employed by firemen it is seldom to be seen except at the extreme corners of the wick. But if not visible, it is a great mistake to assume it absent.

The loop possesses the advantage that it renders the initial cap invisible with either oil or spirit. Invisible though it may ordinarily be, it is not difficult to prove its existence if copper is the material of the loop. By touching the loop with hydrochloric acid or even with saliva before swinging it into the flame, the fuel cap is tinged green for a few moments, and its presence revealed. Experience has also shown that some colzas contain, in probably minute proportions, an impurity which has the effect of making the initial cap visible with the copper loop. Should this be found, the difficulty may be avoided by using a nickel

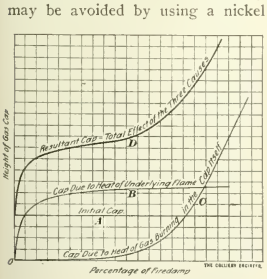


Fig. 3

loop, or, better still, by getting purer oil. Up to the present, the writer has not met with any trouble of this sort when burning spirits.

It is the peculiarity of rendering the initial cap invisible that renders the loop so valuable in estimating proportions of firedamp below 1 per cent. After a little training, it is not difficult to see one-fourth per cent. of the gas by aid of the device.

Intensification of the Cap.—Many experimenters have endeavored to intensify the gas cap by means of metallic salts. The copper loop allows of a vivid intensification being brought about. The method consists of introducing 1 or 1½ per cent. of carbon tetrachloride into the lamp oil or spirit, at a cost of roughly one-eighth of a cent per lamp per shift. This addition has no effect on the working flame, but when the loop is moved into it the

Fig. 4

flame becomes green (due to copper chloride) and the gas cap, if present, a bright blue (due to copper oxide). The brilliancy of the cap may be gathered from the photograph reproduced in Fig. 4; it shows, actual size, the cap given by 2½ per cent. of firedamp. The lamp was burning a mixture of 2 parts of colza and one of paraffin, plus 1½ per cent. of carbon tetrachloride. The coloration does not fade away; it lasts as long as the oil lasts. The cap is so strong that it can be seen in the full glare of an electric light. A lamp so treated is useful as a gas indicator in motor rooms, or in faces where electric coal cutters are at work. The method has one drawback, namely that the initial cap is no longer visible. It is found, however, that the initial cap is of violet color, while that produced by firedamp is blue, and, of course, of larger size.

The Mode of Formation of Gas Caps.—The "loop" has been the

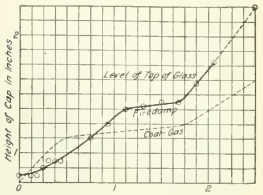


Fig. 5. Percentage of Inflammable Gas

means of increasing our knowledge of the genesis of gas caps. This resulted from the greatly enhanced precision the loop affords in studying the caps produced by very low gas percentages. Every one is familiar with the graphical method of representing the relation between the height of cap and the proportion of inflammable gas present; and a number of curves (constructed by plotting heights of cap as ordinates and gas proportions as abscissas) have been published from time to time. However, the very indefinite indications obtainable by an ordinary lowered flame when the percentages are below 2 has caused the double bend (see *D*, Fig. 3) in such a curve to have been missed. The very pronounced flattening of the curve at and about 1¼ per cent. (see Fig. 5) was discovered by the writer when standardizing the loop device.* At that time he could not explain the phenomenon; but since, with Professor Smithells' help, he has been able to suggest the following explanation. [It must be clearly understood that the double bend is no peculiarity of the "loop" method of testing; only the uncertainty of the indications prevents the same effect being witnessed with the lowered flame.]

The cap one sees over a test flame is the effect of three causes acting in combination. In the first place

*See Fig. 3, page 440, The Colliery Engineer, March, 1913.

there is the initial or full cap; no matter whether it is visible or invisible in pure air, the initial cap adds its volume to that of the gas cap. To the writer it seems that the only possible way of showing the influence of the initial cap, in the present state of our knowledge, is by the straight line *A*, Fig. 3. Secondly, there is the influence of the heat generated by the burning gas in the cap. In an explosion (which may be viewed as an infinite cap) this influence is paramount; the extent of an explosion of gas is independent of the flame which initiated it; the burning gas, of itself, generates enough heat to propagate combustion through the explosive mixture. We may learn from this that the cap formative, or cap extending, influence of the burning gas in the cap must increase as the gas percentage increases, somewhat in the manner illustrated by curve *C*. There remains the influence of the safety-lamp flame itself. With very low proportions of gas (less than 1 per cent.) the flame is a very important factor; but its relative importance decreases as the amount of gas increases. As the cap gets longer its tip gets further from the underlying flame whose power of lengthening the cap—and we are only considering the height of the cap—must, therefore, become subservient to that of the burning gas in the cap. So it would seem that the flame's influence, *per se*, may be represented by such a curve as *B*. Summing the ordinates of curves *A*, *B*, and *C*, we obtain *D*, representing the three influences acting together; and we know as a fact that such a double bend is present in the gas-cap curve obtained by means of the loop with percentages ranging between zero and 2 per cent. Fig. 3 does not pretend to show the three influences strictly to scale. So far the writer has not been able to devise a method to separate those illustrated by *B* and *C* in order to permit of their exact determination.

Further Tests.—A committee of the Scottish Mining Institute is making further investigations into the loop method, especially to find how it succeeds in the hands of mine firemen, and the writer would be glad to hear of any results obtained in American mines with the device. It is not patented.

The Smoky River Coal Field

*By Frank E. O'Neal**

Within the past year numerous reports have been published of the finding of anthracite coal on the Smoky River in the vicinity of the mountains. Doctor Hoppe, of Oakland, Calif., visited the field during the summer past and on his return gave several interviews to different newspapers with the result that articles were published which stated that the coal found was similar to the Pennsylvania anthracite. According to these statements this field will soon be opened by a branch line of the Canadian Northern Railway.

At present the demand for domestic fuel in Alberta is supplied by lignite coal of very good quality. This lignite occurs in enormous quantities over nearly the whole province and is mined at a number of points, generally wherever there is a demand sufficient to warrant installing a small plant. The quality of this lignite and the low price at which it may be placed on the market has so far prevented any competition from the higher grade coals in the western bituminous field.

Along the outer ranges of the mountains in the foot-hill belt these beds of lignite have been slightly disturbed and are of a higher grade than those within the flat lying strata of the central portion of the province. In the southern part of the province, beds of the next lower coal bearing horizon are exposed. This series, known as the Belly River formation produces, in the vicinity of Lethbridge, a very good grade of lignite coal that is much in demand for domestic purposes. Within the outer ranges of the mountains, and along the front of the first ranges, are found the beds of the third coal horizon, known as the Kootanie formation. It is this formation that produces all the bituminous coal found in the province. In a few places, of local extent, this coal has been found to resemble anthracite; however, it is not to be compared to Pennsylvania anthracite.

The largest body of this so-called anthracite is found at Bankhead and at Canmore, on the main line of the Canadian Pacific. Some of the seams in the lower portion of the Kootanie formation are, in other places, found to contain a high percentage of fixed carbon, especially where they have been highly metamorphosed. In the Miette Basin, of Jasper Park, there is a small seam near the base of this formation that contains over 80 per cent. of fixed carbon.

The coal in this seam has been called anthracite, but is not to be compared to the Pennsylvania anthracite, either in hardness, luster, or fracture.

There is no doubt but that the Kootanie formation occurs in the vicinity of the Smoky River, where it is likely to be coal bearing, for it has long been known that Cretaceous rocks are exposed as far north as the Peace River.

In locating coal claims in Alberta it is well to bear in mind that the best grades of bituminous coal are found where the strata have been the least disturbed. This is generally along the front of the first ranges or in the first longitudinal valley. Farther within the mountains the coal measures are usually more disturbed and the coal, when mined, produces a very high percentage of slack.

Coal has been reported to occur in large quantities on the Smoky River and its tributaries. It is only within the last 2 years that any interest has been taken in this field and this was chiefly because it was reported that the Canadian Northern Railway had acquired lease to a large tract of coal land in this vicinity, which they intended to exploit by means of a branch line from their transcontinental road. To develop this field

*Pocahontas, Alberta.

it will be necessary to build at least 80 miles of railroad at a cost of not less than $25,000 per mile.

These Smoky River coal fields are at present, owing to their situation, of little value, but they will no doubt all be staked within a few years. As the railroads now building into the Peace River country are extended westward there will naturally arise a demand for steam coal, and as these fields are within a reasonable distance there will undoubtedly be branch lines constructed to develop them. A branch from this direction is more feasible than one from the south and can be built at a lower cost.

Up to the present time this field has not been sufficiently prospected to prove there is anthracite here; however, the geological conditions are similar to those farther south and it is reasonable to expect that the coal will be found to be similar also.

In the Province of Alberta a coal claim of 2,560 acres may be leased from the Dominion Government by one person, at a yearly rental of $1 per acre payable in advance. Added to this the Dominion Government charges a royalty of 5 cents per ton mined. As a result of this yearly rental it is too expensive to hold a coal claim for many years before it is reached by a railroad. Owing to this fact there are at the present time, in the Province of Alberta, many fine tracts of coal which are still available for location.

Air Cylinder Lubrication

Word comes from South Africa that no oil should be used in the air cylinders of air compressors, but instead a finely pulverized air floated graphite. It is well known that bad air is delivered from air compressors using oil and that the valves are apt to gum, and stick, also that the air is likely to heat to such an extent under certain conditions as to set fire to the accumulated oil deposits and cause explosions.

Graphite is said to overcome this difficulty and not to contaminate the air in the mines when the air is exhausted from the drills.

Prospecting Bering River Coal Field

Methods Required by the Nature of the Country, Which is Rough, Mountainous, and Heavily Covered With Moss and Other Vegetation

By W. R. Crane

IN the Bering River coal fields the lower portions of the mountains are densely wooded. The middle tions are covered with extensive areas of willow, alder, and salmon bushes, which as the summit is approached give way to a thick growth of moss and other low growing plants with occasional thickets of low bushes.

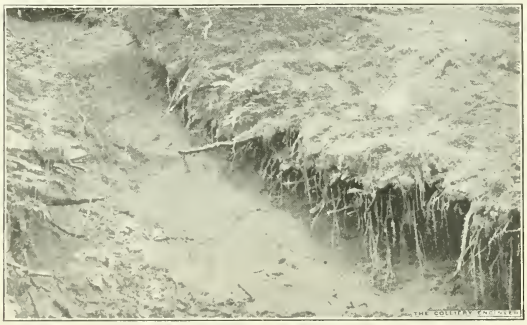


Fig. 1. Outcrop of Coal on Cunningham Ridge

The coal bearing region is mountainous, although the elevations seldom exceed 2,500 feet. Naturally, one would expect that the outcrops of coal beds would occur on cliffs, along gorges and in cañons; this is rarely the case, however, for in only a few localities do coal beds outcrop in the more rugged portions of the field. There are two districts where such outcrops occur, namely, Carbon Mountain and Lake Tokun, and the greater portions of these districts are far from being rugged or precipitous.

The deep cuts and gorges usually occur below timber line, and particularly on the southern exposures they are found to have their walls covered with a thick layer of moss and fallen trees, rendering a close examination difficult or impossible. Above timber line and often up to the summit, the moss assumes more the nature of a sod, the larger part of the growths occurring below the surface in the slide rock. The result is a tangled, tenacious mass consisting of soil, sand, and gravel, and broken rock which must be removed before pick and shovel can be employed to advantage. Fig. 1 shows the outcrop of the coal bed on Cunningham Ridge and the moss covering over the top.

Unless the slope is 38 degrees, or more, the downward movement of the loose materials is checked by the moss covering, although large masses occasionally break loose due to the presence of an excessive amount of water. Practically all coal outcrops are hidden from view, and it is only by painstaking search that traces and indications of them are discovered.

Near the summit of the mountains the covering of moss becomes thinner and may disappear altogether, in which case the talus on the steep slopes is practically the only obstacle to be contended with.

Many of the best coal outcrops occur on the summit of the mountains particularly the narrow ridges connecting the larger mountain masses

which are usually exposed by frost, snow, and excessive rainfalls. Figs. 2 and 3 are examples of this kind.

The burrowing animals, particularly the marmots, and bears seeking to dig them out of their holes, often expose coal outcrops. Below timber, fallen trees frequently expose coal beds, the moss attached to the roots being torn from the rocks over an area of many square feet. Landslides may occur over as much as an acre of highly inclined formations, but moving parallel with the strata do not expose the interstratified beds of coal, as shown in Fig. 4.

Fig. 2. Slide of Trees, Moss, and Earth, Exposing Inclined Strata

The prospector has learned to determine whether the rock is close to the surface by stamping or pounding on the moss; if only a few inches beneath the moss, a dull hollow sound is emitted; no sound forthcoming he knows that the rock lies some distance below the surface. Further, a terraced appearance of the slope may indicate the presence of a coal bed or moderately soft formation, which, sloughing away from the outcrop, causes the moss to slip, but not necessarily to break away. Many outcrops of coal are exposed, however, by the breaking away of the moss covering, whenever there is a movement of loose materials beneath.

The prospector's tools are pick and shovel and occasionally a bar, which must be supplemented by muscles, patience, a keen sense of observation, and good judgment. Further, he should know the different formations associated with coal beds, understand the relation between dip and strike, and in this field where folding and faulting are so universal, be able to keep his bearings and not be led into grievous mistakes.

In one case where an extensive bed of coal was supposed to have been discovered it turned out to be a moderately sized bed closely folded, as shown in Fig. 5. Really, what appears to be the top and bottom rocks is bottom rock brought practically into parallelism by extensive folding. Instead of the 30-foot coal bed highly inclined, there was only the remnant of a 12-foot bed.

This case emphasizes the necessity for careful interpretation of conditions. Masses of rock having slid into the bed may be mistaken for irregularities in the bed, and similarly an outcrop may be moved out of place, inclined, or its thickness apparently increased or decreased. Folding and faulting probably produce the most misleading results by increasing or diminishing the thickness of the deposit, or causing it to disappear altogether.

Failure to appreciate the difference between correct and incorrect measurements of deposits leads to serious mistakes which are of more frequent occurrence than is commonly supposed. One coal bed in this field has been measured by two supposedly reliable men. In neither case was the bottom rock exposed, and apparently the measurements were taken on a diagonal line, following along an exposure made by an earth slide, rather than on a line normal to the dip and strike of the bed. Examples of this are shown in Fig. 6, where it is evident that were the line CB followed, a larger amount of work would be required to trench across to the bottom rock, but by cutting trenches in the exposed outcrop to the limits of the slide, then offsetting several feet and forming another line of trench below, it was possible to rapidly sectionalize and examine the outcrop and at the same time take advantage of the cleared space made by the slide.

There are times, regardless of knowledge or experience, when the inability to see beyond the point of his pick places the prospector at a decided disadvantage and he must give way to the miner to explore by drift or shaft, or to the driller to produce his records; even then the results may be unsatisfactory in many instances.

In this field, trenching is preferred to pit digging. Unless the outcrop has been located, pit digging is necessary to secure definite information regarding the coal, its quality, dip, strike, etc.

Trenches many rods long are found on the mountain slopes above timber line which were maintained as nearly as possible normal to the supposed outcrop of the coal beds sought. Change of strike is responsible, therefore, for much unprofitable work, for to dig a trench parallel with the strike of the strata is unproductive of results, and lack of care in properly exposing the bed rock to ascertain the strike is also responsible for much fruitless labor.

Every trench on new ground where the strike of the strata is not known, should begin with a pit carried to bed rock, and such information secured, the direction of the trench is then readily determined.

The season for prospecting by digging pits and trenches at elevations above 1,500 feet is limited to the months of August, September,

and October, owing to snow covering the outcrop, although the period may commence in the middle of July and extend into November. Snow banks, even when not partially turned to ice, are more difficult to dig through than an equal amount of moss, earth, and slide rock. Fig. 4 shows a prospect ditch through snow banks peared and the prospector has commenced his work, one may find frozen ground which is fully as difficult to excavate as slide rock. Sand and gravel when frozen together are to all intents and purposes sandstone and pudding stone.

The writer encountered frozen ground on the southern slope of outfit, although with blocky sandstone a bar will be found useful.

Trenches are excavated from 18 to 24 inches wide at the surface and should not be narrower than 12 inches at the bottom. For convenience 14 inches is preferable. The depth of the trench varies from 10 to 24 inches with the thickness of

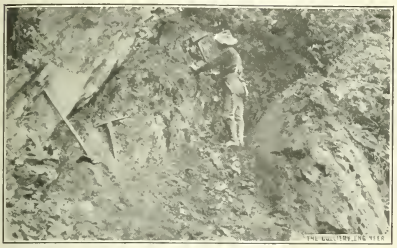


Fig. 3. Prospect Pit on Outcrop of Coal on Side of Gorge

Fig. 4. Prospect Ditch, Dug through Snow on the Fourth of July, Summit of Carbon Mountain.

on the summit of Carbon Mountain, July 4, 1912. Further, the snow banks limit the observation to the ridges and more elevated areas which are more likely to be covered with vegetation. There are, of course, certain portions of the mountains at the elevation given that are, through exposure, sun, and wind, freed from snow earlier than other portions and can be prospected, therefore, at an earlier date and for a longer period.

Even after the snow has disappeared and the prospector has commenced his work, one may find frozen ground which is fully as difficult to excavate as slide rock. Sand and gravel when frozen together are to all intents and purposes sandstone and pudding stone.

The writer encountered frozen ground on the southern slope of Monument Mountain, Cunningham Ridge, at a depth of 6 to 8 inches as late as the middle of August. Difficulty was experienced in securing the section of the large coal outcrops there, owing to the frozen condition of the disintegrated material covering the outcrop.

When conditions are favorable, trenching can be carried on rapidly when two men work together. An earth pick and two long-handled, round-pointed shovels constitute the outfit, although with blocky sandstone a bar will be found useful.

Trenches are excavated from 18 to 24 inches wide at the surface and should not be narrower than 12 inches at the bottom. For convenience 14 inches is preferable. The depth of the trench varies from 10 to 24 inches with the thickness of the covering although in cases they were made 6 feet deep.

Two men alternating with pick and shovel can excavate 10 cubic yards per day. This is the average of a number of representative day's work of 8 hours in different places under varying conditions of formation and depth of the trenches.

Good, experienced prospectors command $3 per day and board, which is estimated at $1 per day, making the cost of excavating 10 cubic yards $8, or $.80 per cubic yard. Much of the prospecting is done by prospective locators, in which case the cost to such an individual, not counting his time, is simply that of his board, which would reduce the cost to about $.20 per cubic yard.

Owing to most outcrops occurring on slopes, often quite steep, the handling of the excavated material is readily accomplished. Pits often as deep as 8 to 10 feet may have bottoms extending to the surface of the slopes or they may be made to do so with little labor, as shown in Fig. 3. It does not then materially increase the cost of work, for ease of excavating the soft coal of the outcrops offsets in a large measure the inconvenience and difficulties of

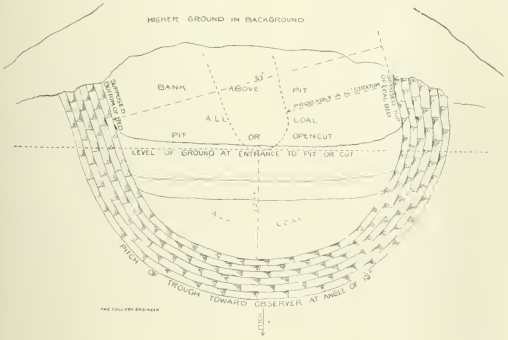


Fig. 5. Closely Folded Coal Bed, Having Appearance of Highly Inclined Bed on Outcrop

working in narrower quarters. Observations on trenching and digging pits seems to indicate that there is hardly sufficient difference in cost between the two methods to make it worth while considering.

There are cases where the top rock has been so badly disintegrated that

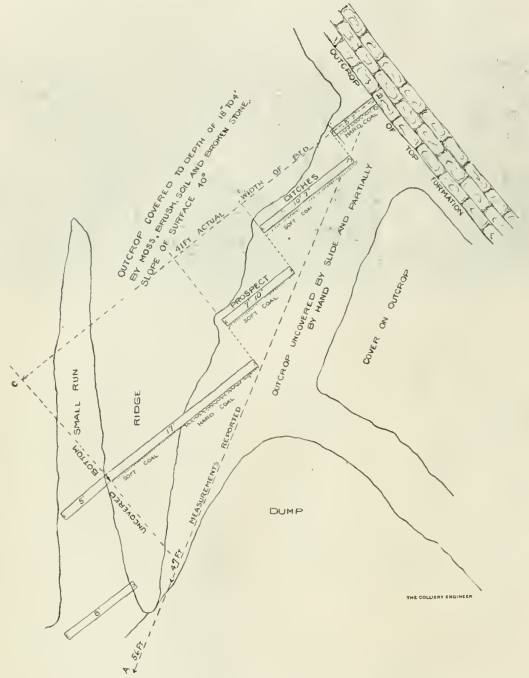


Fig. 6. Correct and Incorrect Methods of Measuring Outcrops

pit digging is difficult and dangerous, as the rock falls readily, not even standing unsupported for a foot in extent. Then handling tons of broken rock renders the work expensive, as the walls cannot be supported except by timbering. Sinking under such conditions is abandoned.

Prospecting by trenching and pits is useful in locating outcrops; but where folding and faulting are as common as in this field, some other means of exploration will have to be adopted. Prospecting by bore holes is now extensively employed in coal fields, the expense being considered of little moment compared with the certainty and definiteness of the information secured. To the present time no attempt has been made in this field to employ drills for prospecting coal; however, considerable drilling has been done for oil on the shores of Controller and Katalla bays and to a limited extent on Bering Lake.

A cost of $7 to $9 per foot for extensive prospect drilling for coal would be prohibitive, and owing to the roughness of the ground the drills now employed in prospecting would not be suited for working in these coal fields.

Under ordinary circumstances diamond drilling would be suited to this work, but the broken condition of the strata might interfere with its usefulness. However, owing to the comparative softness of the formations associated with the coal beds, it is probable that there would be no serious difficulty.

A diamond drill, driven by a gasoline engine, capable of drilling a 3-inch hole, would probably be best suited to prospect work in this field.

To the expense of operating in other fields, additional cost would have to be taken into consideration for moving the apparatus over rough ground, also the cost of distillate for fuel.

It is only by careful, systematic prospecting by drills that sufficient definite information can be secured to warrant development of the coal beds in this field. Much useful information regarding the occurrence of the coal would thus be forthcoming and the importance of the fuel might be greatly enhanced.

The First Connellsville Ovens

The first attempt at commercial coke manufacturing in the Connellsville region, according to the *Connellsville Courier*, was made by the late Judge Provance M. Cormick and associates who constructed two ovens at what is now Raineytown on the west side of the Youghiogheny River below Dawson. After a winter's toil, two boat loads of coke were accumulated, which were floated to Cincinnati. The new fuel did not find a ready market but the Cochrans ran the ovens next winter and this cargo when sent down the river found eager purchasers, thus establishing the value of Connellsville coke for foundry purposes.

The Fayette plant was a later development of the Cochrans and was built on the site of the first ovens after the completion of the Pittsburg and Connellsville Railroad. This was the first coke plant of any pretensions and on its site the Rainey plant, only recently abandoned, was built.

The Origin of Coal

Conditions of Organic Decomposition, or Coalification—Dynamic Agencies Taking Part in Coalification

By Wilbur Greeley Burroughs, M. A.* (Continued from December)

THE transformation of vegetable matter into coal may be divided into two stages: The putrefaction stage, which is chiefly a biochemical process; and second, the alteration or metamorphic stage, which is a dynamo-chemical action.

The Putrefaction Stage.—When leaves, fruits, twigs, trunks of trees, etc., fall to the solid ground, exposed to the atmosphere, they decay and the larger part of their substance is returned to the atmosphere. If, however, the vegetation falls into water, it usually undergoes only a slow decay, which is a different type of decay from that suffered by the vegetation which falls on drier land

The vegetal matter which slowly becomes changed beneath the water, undergoes a deoxygenation and dehydrogenation process. This is accomplished by fermentation or maceration in which the plant tissues are attacked by insects, worms, amoeboids, fungi, and bacteria, the anaerobic bacteria being the most important microorganism in the formation of coal. Due to this attack by minute plants and animals, the plant tissues finally break down into a dark, subgelatinous, plastic or liquid jelly-like mass, the black peat, the jelly, forming the amorphous ground mass of coal and cementing the remaining plant tissues and sediment together. This jelly is called the "fundamental matter," or "fundamental jelly." Other factors remaining unchanged, the putrefaction process finally ceases, due to the extinction of bacteria by exhaustion of the available oxygen, "or through the development, as the result of their own activities (R. 1), of humic, ulmic, tannic, or other antiseptic toxic by-products in such amount as to make it impossible for them longer to exist." With the cessation of the destructive activity of the microorganisms, of which the anaerobic bacteria are the most enduring, no further dismemberment of the vegetal or animal structure takes place. Peat has now been formed by this jellification process, but whatever further alteration or metamorphism the coal forming organic matter may experience through dynamic or chemical agencies, nothing short of pressure, rock deformation, fusion, displacement by crystallization, or exposure to weathering, can cause further serious disaggregation of the remaining organic tissue or mechanical residues.

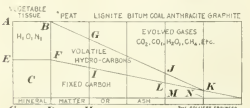


FIG. 6. DIAGRAM SHOWING CHANGES OCCURRING IN THE TRANSFORMATION OF VEGETABLE TISSUE TO GRAPHITE (AFTER NEWBERRY)

The gases given off by the decay of cellulose ($C_6H_{10}O_5$), the principal initial compound contained in vegetation, in the open air, are carbon dioxide (CO_2), and water (H_2O), the carbon and hydrogen of the cellulose having united with the oxygen of the air. Under water, however, the atmospheric oxygen is largely excluded, and the elements of the vegetation unite with one another to a larger extent, the oxygen of the air taking but a subordinate part. The gases liberated under these conditions are marsh gas (CH_4), which often can be seen bubbling up from many of the present-day swamps, carbon dioxide, water, etc. As this process continues and these gases escape, the percentage of carbon remaining in the solid matter will be continually increased, for in the formation of marsh gas (CH_4), the hydrogen is exhausted four times as rapidly as the carbon; in carbon dioxide (CO_2), the oxygen is exhausted twice as rapidly as the carbon, etc. The loss of volatile matter, and the increasing percentage of carbon, occurs, not only in the formation of peat, which we have already partially considered, but also, throughout the entire series from vegetal matter to anthracite coal and graphite.

Table 1 gives analyses of the substances formed in the series, starting with vegetable matter and ending with anthracite coal. The increase in the percentage of carbon is clearly shown.

TABLE 1. AVERAGE COMPOSITION OF FUELS (R.3)

	C	H	N	O
Wood	49.65	6.23	.92	43.20
Peat	55.44	6.28	1.72	35.56
Lignite	72.95	5.24	1.31	20.50
Bituminous coal	84.24	5.55	1.52	8.69
Anthracite	93.50	2.81	.97	2.72

In the diagram, Fig. 6, the rectangle $A\,B\,C\,D$ represents a given (R. 7) volume of fresh vegetable matter, containing a small percentage of mineral matter, the rest of the vegetable matter being composed of organic substances consisting of 50 per cent. carbon ($E\,F\,C\,D$), and 50 per cent. hydrogen, oxygen, and nitrogen ($A\,B\,E\,F$). In the change from the fresh vegetable matter to peat, part of these four elements passes off as gaseous compounds, so that the remaining volume of peat is less ($B\,G\,D\,H$) than the original volume of the vegetal matter ($A\,B\,C\,D$). Since the hydrogen, oxygen, and nitrogen have passed off in larger amounts than the carbon, the percentage of carbon in the peat will be higher than it was in the fresh vegetable tissue. This can be readily seen from the diagram, by comparing $B\,F\,G\,I$ and $F\,I\,D\,H$ and $A\,B\,E\,F$ and $E\,F\,C\,D$. The actual weight of mineral matter will be the same, but its percentage will be larger, due to the loss of gas. This change, continued long enough, will result finally in the formation of anthracite coal, in which the per cent. of carbon ($L\,K\,M\,N$) is high and that of the other organic elements is low ($J\,K\,L$). A still further change results in graphite.

Let us for a moment consider peat, the product of the first stage in the

*Oberlin, Ohio.

development of coal from vegetable matter, the process of transformation being biochemical.

The chemical changes which take place in the transformation of Sphagnum, the chief plant of some of the present peat bogs, through the various grades of peat, are given in Table 2 (R. 3).

Table 2. Analyses of Sphagnum and Peat

	A	*B*	*C*	*D*	*E*	*F*	*G*
C	49.88	50.33	50.86	59.71	59.70	59.71	62.54
H	6.54	5.99	5.80	5.27	5.70	5.27	6.81
O	42.42	42.63	42.57	32.07	33.04	32.07	29.24
N	1.16	1.05	.77	2.95	1.56	2.95	1.41

A = Sphagnum. *B* = light peat, near surface. *C* = light peat. *D* = moderately light peat. *E* = black peat. *F* = black peat. *G* = heavy brown peat.

The vegetal matter consists of any plants which can thrive in marshes. These plants grow, die, and are buried, layer upon layer. On the surface of the bog we see the growing plants, a little below the surface their recognizable remains can be found; still deeper, we come upon a black, semigelatinous substance from which the vegetable structure has largely disappeared. This substance is peat, saturated with moisture.

Under the most favorable conditions, peat has been known to form as rapidly as 1 foot in 5 years. This peat was formed in small, stagnant basins, where no waves or currents interfered with its accumulation. In larger or deeper basins, the rate of growth is less. A rate of 1 foot in 10 years is believed to be a fair average maximum for ordinarily favorable conditions. Take for example a peat, later changed to coal, that was formed in a deep bog, for a bog must necessarily have been deep to yield thick beds of coal. One foot of peat at the surface laid down in 10 years, "will later shrink to 3 inches, due to the loss of moisture; its loss by partial decomposition has been estimated at about one-fourth of the vegetable matter of which it is composed, but as its specific gravity increases to about twice what it was before compression, the original 3 inches will be compressed to, say, one-half of three-quarters of 3 inches, or $1\frac{1}{8}$ inches, and probably less in very deep bogs. This gives about 1 foot in a century as the rate of accumulation of the buried peat (R. 4)."

IV. Dynamic Agencies Taking Part in Coalification.

Up to this point, we have discussed the first stage, the essentially biochemical process, of coalification, which leads probably no further than the formation of the peats. We will now consider the second, or dynamo-chemical stage of coalification in which occurs the transformation, as the direct or indirect result of dynamic influences, of the coalifying material into lignite, bituminous coals, anthracite, etc.

It has been taken for granted by many in the past, that at least to produce the higher grades of coal such as anthracite, strong folding of the coal bearing strata was necessary, this folding developing sufficient heat and pressure for this degree of metamorphism. M. R. Campbell, however, has argued that although the series of transformations are due to chemical changes induced by heat, the progressive changes are controlled almost wholly by the escape of the gaseous products of the chemical change. Take for example the anthracite coals of Pennsylvania. They were formed not so much because of heat and pressure, as because of the cracking of the rocks, which allowed thorough oxidation. An equal amount of folding, in the Pocono rocks of Maryland (R. 7), has not produced anthracite, as there no outlets for the free escape of gases were formed.

It is, therefore, evident that if the conditions are such that the escape of gases is unobstructed, the transformation will be rapid; but, if the gases escape slowly and with great difficulty, the change in the coal will be correspondingly retarded. Thus, in the transformation from vegetable matter through the series of peats, lignites, subbituminous and bituminous, and anthracite coal, until the end is reached in graphite, the essential chemical result of the transformation is the deoxygenation, and dehydrogenation of the vegetal matter, the reduction of the oxygen being the more important; for the deoxygenation of the organic matter is the true index of the progress made in the transformation of the vegetal matter, and also, the index of efficiency of the fuel.

As the series of transformations from vegetal matter to graphite progresses, the bulk of the initial substance becomes less and less (see diagram by Newberry). We have already seen how 1 foot of peat at the surface laid down in 10 years, shrinks to $1\frac{1}{8}$ inches; and that 1 foot of peat in a century is the rate of accumulation in deep bogs. Now let us go still further and ascertain how much peat was required to make the coal beds which are of such value to man, and how long a period was involved in the process of accumulation.

Concerning this problem, G. H. Ashley writes as follows (R. 4):

"The weight of a cubic foot of peat from the lower part of the bed will average about 50 pounds. Withdrawing one-third of that weight for the loss of water, and one-third of the remainder for the loss by distillation, there is left, roundly, 25 pounds. A cubic foot of coal from the Appalachian field on the average, will have a weight of about $87\frac{1}{2}$ pounds. Therefore, to make 1 foot of such coal will require $3\frac{1}{2}$ feet of well-compressed peat. The factor 3 has been selected as representing, not the shrinkage of the whole bed, but the number of feet of well-compacted, deeply-buried old peat necessary to produce 1 foot of bituminous coal of the general character of the Pittsburg coal of Pennsylvania. Applying this to our estimate, that 1 foot of such peat requires a century for its deposition, and we have 300 years as the time necessary for the laying down of 1 foot of average bituminous coal. At this rate the Pittsburg bed where 7 feet thick, required 2,100 years for

its accumulation, and 4,000 years in its best development in the Georges Creek basin of Maryland. Turning to the Appalachian field as a whole, where it has been estimated that 300 feet of coal as a maximum were laid down, and it would appear that 90,000 years, say, roundly, 100,000 years, were required for the laying down of this coal.

The general geology of the region in which coal beds are located plays an important part in the transformation of the lower grades of coal to the higher grades of coal. A knowledge of the factors which are vital in this transformation of the coal is of value, not only from a theoretical standpoint, but also from a practical one. For from the geological history of a region, one can often tell what is the quality of the coal which is buried beneath the surface. It is essential that such surface indications as are obtainable bearing on this problem be recorded and correctly interpreted.

The following factors should be taken into account in determining the history of the coal's transformation, as well as the present quality of the coal:

(*a*) The geological age of the coal bearing formations should be ascertained, for the older rocks will be more likely to contain a higher grade of coal than the younger rock formations, other conditions being equal, because the older coal has had a longer time in which its gases were allowed to escape. Even suppose, for example, that the strata above the older coal were somewhat more impervious, although still pervious to quite an extent, than the strata above the younger coal, the older coal would yet be likely to be as good or better than the younger coal which has the more pervious strata above it, because even though less gas was allowed to escape from the older coal through the joints and cracks of the strata, still there would be a longer period of time during which the gas escaped.

(*b*) Since gases escape through joints and cracks and open cleavage planes, a highly developed system of cracks and joints, in a general way, indicates high-grade coal. The Appalachian region affords us an excellent example of coals in various stages of transformation, due to the development of the cracking of the rocks in the various regions. In Rhode Island, where this cracking of the rock formations is very highly developed, we find graphitic coal (R. 6). In Pennsylvania, is anthracite coal in a field where this cracking is less perfectly developed than in the Rhode Island field. Proceeding westward, we find bituminous coal fields in which very open cracks are practically unknown, but joints are of common occurrence.

M. R. Campbell (R. 5), points out, however, that the development of the cracking of the rocks is not an infallible guide in determining the present character of the coal, for time, as we have already noted, enters largely into the transformation. Some very young coals, geologically, may have been subjected to very strong dynamic forces, and may have cracks as well developed as the very oldest Carboniferous coals, but the time may not have been sufficient for the material to have been changed into bituminous coal.

Some of the subbituminous coals on the western face of the Cascade Mountains, in the state of Washington, have this development of cleavage without a corresponding change in quality.

(*c*) Porosity of the rocks above the coal beds, due to coarseness of grain, would allow the escape of gases where the overlying, coarse-grained rock beds are thin; but where great thicknesses of rock are involved the rocks are practically impervious.

(*d*) The dip of the strata should be taken into account, for with more steeply dipping strata, the gases from the coal would find easier outlet along the bedding planes, than where the strata is only gently dipping, or horizontal.

(*e*) Igneous intrusions, whose heat is intense and local, would hasten the transformation of the lower grades of coal into anthracite and graphite. Examples of this are, the Cerrillos coal field of New Mexico, and the Crested Butte district of Colorado (R. 7), where bituminous coal has been locally changed to anthracite by near-by igneous intrusions.

The National Conservation Congress

Summing up the work of the Fifth National Conservation Congress, held in Washington last November, the following statement was given out by Charles L. Pack, president, at the headquarters of the Congress:

Among the fourteen hundred delegates present at the Fifth National Conservation Congress were more foresters than had ever heretofore attended any similar meeting in this country. The forestry work accomplished, as evidenced by the twelve printed reports in pamphlet form, is considered by forestry experts and lumbermen to be the best work that up to this time has been done for American forestry and lumbering.

The adoption by the Conservation Congress of the recommendations unanimously presented by its committee on water-power was a long step forward in the development of a definite governmental policy recognizing clearly the principle of federal control and also recognizing clearly the necessity of offering to the investor opportunity to invest his time and money in the development of water-power under conditions which safeguard both the public interest and his investment.

The committee on water-power was made up of ten men, exceptionally qualified by knowledge of this subject in all its aspects. Under the able chairmanship of Dr. George F. Swain, president of the American Society of Civil Engineers, it worked out and presented not a mere declaration of principles, but concrete and specific recommendations which should be of great value to the Government in framing the legislation that is needed to convert the present comparative inactivity in water-power development into a period of active conservation by use.

The fact that a committee made up not only of professional experts of the highest distinction, some of whom are actively associated with the water-power interests, but including also such men as former Secretary of War Stimson, Mr. Gifford Pinchot, and Mr. Lewis B. Stillwell, were able to agree upon a definite and constructive program and that this program received the emphatic indorsement of the Conservation Congress, is demonstration of the public spirit of the committee and the ability of the Congress to accomplish effective and constructive work. All true conservationists will hope that our national government will promptly enact the legislation that is so greatly needed.

The Mount Pleasant Bath House

The Scranton Coal Co. has recently completed a bath house for its employes at the Mount Pleasant colliery, Scranton, Pa., which has the unique distinction of being constructed entirely of material on hand at the mine and by company labor, at a great saving over one built by contract, and it represents a bath house the cost of which is within the limits of the smallest operator.

Like the outside, it is painted white inside except within 7 feet of the floor, where the walls are painted black. The floor of the shower compartment is 6 inches lower than that of the main room. There are 72 lockers in the two tiers, which is a sufficient number to accommodate all the men who wish to bathe at the mine. The lockers are painted black, made of wood and well ventilated, the doors being made of perforated steel plate. One trouble with locker doors at many mines has been that of the screws coming loose in the water-soaked wood; this has been eliminated, for instead of screws, $\frac{3}{16}'' \times 1\frac{1}{8}''$ stove bolts are used.

In the showers, a combination of steam and cold water regulated by a McDaniel suction-feed supplies the water in a constant and warm shower. The suction feed acts on the principle of an ejector. Rent is free to the men using the bath house. The following notice is posted outside of the building.

NOTICE

This building has been erected and finished for the comfort and convenience of the employes of this colliery and we expect those who use it to be careful not to damage it in

Fig. 1. Bath House and Emergency Hospital

any way and also to report any infraction of any rules made for the preservation of the building and its contents. The building will be opened at 5:30 A. M. and remain open until 7:30, when it will be cleaned and made ready for the return of the men.

Between 8 A. M. and 4 P. M. the key will be at the office and will be furnished to any one wishing to use the building during that time. At 4 P. M. the building will be thrown open and remain open until 6 P. M., when the key will be sent to the office for the night.

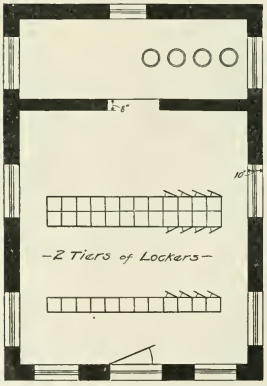


Fig. 2. Plan of Bath House, Mt. Pleasant Mine

RULES

Rule 1.—Applications for lockers must be made to the Outside Foreman; notice that employes are going to vacate lockers must also be given.

Rule 2.—Any person or persons damaging building or fittings or interfering with lockers other than their own will be denied the use of the premises.

Rule 3.—All old clothes, shoes, etc., must be put outside the building in a receptacle provided for that purpose on the outside of the building. Mine lamps will not be permitted in the building at any time, neither can they be stored in the lockers.

Rule 4.—When the baths are not in use, the last man to use same must see that the water is shut off tight and that there is no leakage visible in the showers.

Rule 5.—Employes must not tamper with windows, as the building will be ventilated properly by the man in charge.

Rule 6.—No nails or spikes must be driven in the lockers. Coat hooks will be permitted when put up by our own carpenter.

Any infractions of the above rules when reported to us will be treated as strictly confidential.

Scranton Coal Co.

To the right of the bath house as will be noticed in Fig. 1 is a small building, formerly a powder house, which has been cleaned, plastered, painted and fixed up as an emergency hospital. However, its sole purpose is more of a transient hospital than anything else. When a man is brought from the mines injured and the ambulance or carriage is not ready for him, he is taken to this hospital and made comfortable.

Briquets in France

The production of briquets in France increased from 1,729,585 tons in 1911 to 1,793,459 tons in 1912. The department of the Nord showed an increase of nearly 41,000 tons; that of the Pas-de-Calais, 23,000 tons. This output in 1912 is the product of 11 companies.

German Rescue Organization

Method of Instruction in Use and Care of Breathing Apparatus at the Clausthal Central Station

By Bergassessor Breyhan, Duderstadt*

THE duties of the Clausthal rescue station manager are specified by rules, and his relations with the different mines are confidential. The manager must supervise the rescue corps attached to the central station and inspect, without previous notice, the rescue department of every mine once yearly.

Instruction at the Clausthal central station is given to the students of the School of Mines and to the life-saving departments of the associated mines; in general the course is of a uniform nature, and the students are given an opportunity to learn the theoretical branch of life saving.

At first a survey is taken of rescue work in general, of its importance and necessity, in connection with a historical sketch. Special stress is placed upon having a knowledge of all possible dangers which may befall the miner. For this reason it is necessary to explain what unbreathable gases will be found in mines, and under what conditions and suppositions; also to make clear to the students in what way and with what effect the inhalation of these gases acts upon the human body. This latter point is of importance, because, if one knows the danger of these gases and their effects, and in what cases they make their appearance, he is able to comprehend the situation and make, beforehand, the necessary arrangement for rescue work. The disaster at the ore mines of the royal mine, Gladbeck, is a striking example of the necessity of such instruction. If the officials who directed the rescue crew and its members in this instance had known that on account of insufficient air supply the explosive gases would gradually contain more carbon monoxide (CO), they would not have proceeded without using the rescue apparatus which they had brought.

Still another case proves the value of instruction pertaining to the effects of gases upon the human body. In a mine of the district, an operator was overcome by gas, after he had made three attempts at rescue work. He was found soon, and was resuscitated. He claimed that on account of a leak in his apparatus he had inhaled smoke; however, no leaks could be found after a most thorough examination. After the man had taken a course at the Clausthal central station, and been taught the effect of gases on the human system, he arrived at a different conclusion concerning the cause of his accident. He said he had thoroughly inspected his apparatus before he made his third effort to penetrate through the gases, and had apparently found everything intact. At that time he had considered it impossible that smoke could penetrate into his apparatus, yet he became sick gradually, which he thought was due to his inhaling smoke. But today he knows that his accident was not caused by explosive gases, but through carbonic acid (H_2CO_3), for he had forgotten, before his third attempt, to place a new cartridge in his apparatus. That his accident resulted from inhaling carbonic acid, he was led to believe because he recovered consciousness in a short time without any after effects, while other miners, overcome by afterdamp, could not be revived, notwithstanding the fact that there were traces of life left in them, and the work of reviving them was continued for hours. He attributes their death to poisoning by carbon monoxide.

After the preparatory instruction, which for the men from the associated mines must be concentrated on only one or two lectures, the practical training with the different rescue apparatus begins; this is in close connection with the lecture in which the theory of the respective apparatus and its mechanical working has been minutely described, and, if necessary, special regard is given to chemical effects and reactions. The training begins with the hose, which is tested in the smoke; after this the regeneration apparatus is taken up. In these drills some of the men are fitted with Westfalia apparatus, while others work with Draeger apparatus. Later on, this is reversed, thus giving the men practice in both; in connection with this, the men also drill with apparatus which they have used before and are thoroughly familiar with. Then follows the drill with the life-restoring devices and the stretcher, in such a way that the latter is handled in the smoke-laden atmosphere in the most realistic manner.

Circumstances decide the way in which the practice drill is conducted. In many cases there is only one official at the mine who understands the apparatuses and puts them together and, in case of necessity, distributes them among the rescue crew, while the latter know little or nothing about them. The central station considers such an arrangement for rescue work as of rather doubtful value, the more so as the responsibility for the good working condition of the apparatus in case of need falls upon the custodian alone. It is considered much better to make each individual of a rescue corps thoroughly familiar with his apparatus, so that he can assume the full responsibility for its working properly. This appears the more advisable since an inspection of every apparatus takes place before being put in use, and permits the operator to satisfy himself of the fitness of his device, thus furnishing a sense of security which favorably influences his nerve and judgment while in action. This point heretofore was not taken into consideration, but

*Translated from *Glückauf*, by Major Karl Kopp. Description of station was given in The Colliery Engineer for December, 1913.

will, without doubt, be a great factor in rescue work in the mines.

The question arises as to whether the apparatuses should be kept in readiness for immediate use, or whether it would not be more advisable to assemble them only in case of need. In favor of the first possibility, it is pointed out that when a disaster occurs, there should be no time lost with putting the different parts together, and that in the excitement which generally prevails, important details might be overlooked. However, when one considers that the rescue corps consists only of picked cool and level-headed men, and that the assembling of the different parts may be accomplished within from 5 to 10 minutes, the argument in support of keeping the apparatus in constant readiness no longer holds good, the more so because there is always a possibility that in an ever-ready apparatus, on account of minor leaks, the supply of oxygen may have decreased, or the potash cartridge, by absorbing moisture from the air, may be no longer fit, or other defects may have developed in or about the air transmission. In such cases the examination, which must take place always before use, would take up much more time than if the apparatus had to be assembled entirely anew. Considering all these circumstances, the Central Station came to the conclusion that, instead of letting the custodian of the rescue apparatus carry the entire responsibility and allowing the members of the corps to go ahead haphazard without being convinced of the safe condition of their apparatus, it would be advisable to train the men so that each one could assemble his own apparatus, before every regular drill or in case of emergency. If the supervision of the warden is secured, in addition, it seems that the highest possible degree of safety for the rescue crew has been obtained. Since at the Clausthal central station the responsibility for the usefulness of the apparatus is left to the wearer, it is perfectly natural that he should understand its construction thoroughly and in testing it be able to find at once any trouble if it exists and how it may be remedied. In order to give the operator this knowledge, the life-saving apparatus is damaged artificially in many ways, and the defects thus created are pointed out to the student.

If one supports the Clausthal central station point of view, it seems to be expedient to assemble and test the apparatus always by fixed rules, as in this way hardly anything can be overlooked. This may prove to be a valuable point in emergency cases, for it is a well-known fact that, even in moments of intense excitement, a habit that has become second nature very seldom fails to work.

The manipulation of the assembling and taking apart of the apparatus is as follows:

First, the supply of oxygen is examined and after closing the flask, it must be observed, through the receding of the Finimeter index, whether or not the bottle connection is air-tight. This is the case when the indicator recedes. Otherwise, there is a leak somewhere, and it is necessary to tighten the outer nut. When the flask is placed in position, care must be taken to see that the rubber washer at the place of connection is not forgotten. If, notwithstanding the tightening of the nut, no air-tight condition can be produced, either the connection piece is not placed properly, or the rubber washer is wanting.

After the examination of the oxygen supply, the potash cartridge is placed in the apparatus. It is in good working condition if one hears upon shaking, a strong rattling noise. In apparatus that is always kept ready for instant use, a new cartridge should be inserted before using it in emergency cases, for it has repeatedly happened that cartridges which have been in the regenerators for some time, though they still rattled when shaken, were useless, as they had been partly used up from leaks in the apparatus.

In the third place the air permeation is tested by blowing in one of the hoses attached to the back of the apparatus. If the air passage is free, a full air-current will pass through the other hose.

With this latter test the establishing of the tightness of the apparatus is closely connected, which in the Westfalia and Draeger apparatuses, model 1904-09, only extends to the back part, while in the Draeger, 1910-11 model, it extends also to the chest bag. This very important examination may also be applied in the Draeger, 1910-11 model only, the test being made as directed by that company, making use of the relief valve in so doing.

After these tests have been made, one must ascertain whether there is in the apparatus sufficient circulation of the air for the strain on the lungs. The measuring of the volume of air circulation by means of the so-called air measuring bag is only occasionally done, because it involves great trouble. The test with the suction and pressure gauge is, however, absolutely necessary. In this process the test for depression is preferred because the indicated power of the suction pipe takes also into consideration the entire resistance in the air passage of the apparatus. The water column of the suction pressure gauge must not be less than 8 centimeters. If less, the apparatus should not be used in emergency cases, because it is then impossible to move the air volume. There are four possible tests for locating the trouble.

In case the life saver should have forgotten the test for air permeation, the suction power of the pipe might, through contraction or obstruction of a place in the air passages of the apparatus, not have the desired effect. A regenerator that is partly used up also destroys a part of the suction power of the pipe. It is further possible that the suction passage of the injector might gradually contract, or become obstructed by dust particles set in motion by the air-current, in such a way that the power of the injector would not

have its full effect. This latter would happen if the level arrangement of the reducing valve was out of order. The first three defects may be repaired by the operator, but the last one mentioned it is advisable to have regulated at the factory.

The work of the mica valves near the mouth, in the Draeger apparatus, should be tested before being used. If they do not work, one should blow vigorously into the mouthpiece just once; then by sucking at the mouthpiece the valves will generally open at once. The proper placing of the mouth pipes in the Westfalia apparatus is of importance; for instance, the exhalation chamber (bag) should be always on the lower left side, in order to allow the receding saliva to flow through the exhalation pipe of the chest bag to the saliva receptacle or sponge bag, otherwise it would clog the respiration pipe and prevent the access of fresh air. This test is, however, not necessary when the mouth pipes are properly placed. The misplacing of the pipes in Westfalia mouth breathing apparatus is generally out of the question, but since it did happen once at the Clausthal central station, it is considered advisable to mention it.

In helmet breathing it is necessary that everything around the head be air-tight; this can be easily tested and accomplished through the test of inflatable pneumatic head-piece and the corrugated flexible respiration pipes.

When the apparatus is taken apart after use, several points must be observed. Above all things, the oxygen must be shut off before the mouthpiece is taken out, or, in helmet breathing, before the air lid or the window has been opened. This must be done on account of the following reasons: If one allowed the oxygen to be free, it might easily absorb small dust particles from the air which would quickly collect in the narrow suction pipe, because the air in the apparatus contains moisture from the exhalation of the operator, thus causing obstruction and endangering the proper working of the apparatus. After the opening of the window, or the air lid, the rubber hose must be ventilated; thereupon the straps are unfastened and the helmet is taken off. It is advisable, after use, to unscrew all the pipes, in order to remove the water in them. The regenerators also must be removed, as their contents might become fluid and run out, thus causing damage by their corrosive action.

The Clausthal central station considers it of importance that the rescue corps at drills should be made to work strenuously in the thickest of smoke, which will cause quite a strain on the lungs. Through this the men will learn how to breathe properly in the apparatus, also be able to detect quickly, on account of the thick smoke and the vigorous breathing, any mistakes they might have made in assembling the apparatus. This will give the wearer confidence in his apparatus. Now and then a regenerator which has been in use before, is installed, in order to show what effect the breathing of carbonic acid will have upon the operator; however, the quantity of the acid which is in the air of the apparatus must be closely watched by frequent tests.

Various attempts have been made to make the drills with the oxygen apparatus cheaper by blowing in ordinary atmospheric air through an air-pump arrangement on the oxygen side of the apparatus; this air will escape, after having been used, through a short piece of rubber hose. However, the Clausthal central station is not in favor of this method, because the authorities consider it more appropriate that, without considering the costs, the rescue corps should be trained in the assembling and testing of the apparatus as if an emergency case were at hand.

Actual tests have demonstrated that two 10-ton electric locomotives placed tandem will pull more than one 20-ton electric locomotive, and not require as heavy a track.

The Purchase of Lubricating Oil

Dr. M. E. McDonnell, in discussing A. D. Smith's paper on Purchase of Lubricating Oil by Specification,* said: "It certainly is difficult to write a reasonable specification. We might get an oil that would be satisfactory for a certain purpose and write specifications covering that particular oil and afterwards find another oil as satisfactory that would not pass these specifications, as it was from a different field or produced by a different method of refining.

"We have been able to lubricate machinery with a comparatively cheap oil, for which we have a specification, in which we tell a producer what we think the oil should be, but it has never been officially issued. It is possible that if this specification was made open, an oil might be obtained from some district which would not be satisfactory, and it is also possible that an oil might be found from another district that would not fulfil the requirements of the specification, yet be just as serviceable and cost considerably less. I think the statement in the paper, that 'it is very difficult to issue a general specification,' has been well borne out.

"One speaker made a statement that is interesting, in relation to fat oil in superheat cylinder lubrication. I understood him to say it is advisable to completely eliminate fat oil. I would like to know if I correctly understood him. We are making a series of tests with paraffin oils containing various fat oils, from nothing up to 20 per cent. We are not convinced as yet whether to entirely eliminate the fatty oil or to use from 5 to 10 per cent.

"Doctor Conradson's point seems to be well taken that a high flash point is not needed in a cylinder lubricant used with superheated steam. A mixture containing some high point material and some lower would lubricate the steam when the engine is working at a low superheat or per-

*The Colliery Engineer July, 1913, Page 681.

haps when no superheat is being used. It is necessary to lubricate the steam, and the oil should accommodate the variations in temperature which occur in the superheat engine."

Mr. T. D. Lynch, Research Engineer, Westinghouse Electric and Manufacturing Co., East Pittsburg, Pa., said: "We, also, have had great difficulty in our attempts to prepare a satisfactory specification for lubricating oils. It was our hope that we might obtain information from the author or from the discussion that would assist us in deciding on the essential points of such a specification, and it is disappointing not to have this hope gratified.

"In the absence of a specification, it has been found necessary for us to adopt certain brands of lubricating oils. The method followed is to obtain a sample of the prospective oil for laboratory tests, examine it carefully for fire, flash, viscosity, specific gravity, color, etc., and then, if the indications are good, a few bearings are kept lubricated for a time, and results observed. If the sample is satisfactory, a trial consignment is ordered and used in the regular lubrication of machinery and the results observed carefully from day to day. If both laboratory test and trial order prove satisfactory, this grade or brand is approved. During the complete investigations the cooperation of the manufacturer is secured so far as possible, we giving him the benefit of our experience and tests in the use of the oils, and securing from him such information concerning the source of raw material, physical and chemical properties and other data. Thus we select one or more brands suitable for our service and eliminate those of an unknown quality.

"We, as consumers, desire more than one source of supply; therefore, more than one manufacturer's brand must be adopted for a given service.

"In the absence of a specification, this plan is adopted because of the absolute need for some check on material purchased.

"We have made 'performance' our slogan, not for oils alone, but for every kind and class of material, and all information obtained is correlated, and put into such permanent form as will enable us to test material and guide us in the performance we may expect. It is often necessary to look into composition, methods of manufacture, treatment, etc., but, after all, the ultimate object is performance. The question is, what will the material do in service and will it fulfil requirements economically?"

Mr. C. H. Garlick, State Steam Boiler Inspector, for Allegheny County, Bessemer Building, Pittsburg, said: "For the past 15 years I have been employed by one of the large oil manufacturing concerns in adjusting the difficulties that occur in connection with the use of lubricants, also in testing them to ascertain their value in overcoming friction.

"I fully agree with Mr. Smith in his statement that the ordinary specifications covering specific gravity, the flash, burning point, and viscosity of oils do not determine the value of oil as a lubricant, as the kind of crude oil used, and the manner of refining and treating it are important factors in its manufacture.

"I do not, however, agree with him, that a cylinder oil should have a flash test of at least 595° F. Oil with a flash test that high is not required even in cylinders where superheated steam is used. The proper lubrication of a steam cylinder is brought about by admitting oil into the steam line just before the steam enters the cylinder. The oil is then atomized, not vaporized, but broken in thousands of atoms. The oil in the form of a film intervenes between the piston and piston walls of the cylinder, the valve, and valve seat, reducing friction in proportion to value of the oil as a lubricant. Steam under a pressure of 100 pounds to a square inch has a temperature of 338° F., at a pressure of 125 pounds, 352°, and at 150 pounds, 367°. My experience has been that the oil with a flash of about 515° will atomize much better at those steam pressures than it will with a higher vaporizing point. Oil with an exceedingly high flash point does not atomize well, and much of it is thrown out the exhaust pipe.

"Water vaporizes when in an open vessel, at a temperature of 212°, but when confined under a pressure of 70 pounds per square inch, at least 300° is attained before the water bursts into steam. The same principle holds good with oil. The vaporizing point in an oil is ascertained with the vessel open to the atmosphere, and oil having a vaporizing point so low as 400° will not vaporize in a steam cylinder where the pressure of the steam is 150 pounds. At a plant using superheated steam under a pressure of 150 pounds, a pyrometer was inserted in the steam chest, which registered a temperature of 666°. The engine was shut down, the steam chest cover quickly removed, and oil that had a flash point of but 417° was found in the steam in a liquid state.

"Oil in a steam cylinder reduces friction and saves fuel. Some years ago, a number of oils were tested in a slow-running 125-horsepower engine, for the purpose of ascertaining their relative values to reduce friction. The engine was connected by means of a belt to the generator. All the bearings were operated in a bath of oil, the ideal method of shaft lubrication. After the cylinder of the engine and other parts were known to be perfectly lubricated, the load was thrown off the engine, and indicator cards were taken simultaneously from both ends of the cylinder. A series of these cards carefully measured, showed that 18 horsepower was required to overcome the friction of the engine and generator with all parts perfectly lubricated. The load was then thrown on the engine, which was operated for 6½ hours, during which no cylinder oil was permitted to enter the cylinder, the other bearings, of course, being lubricated in the usual manner. At the end of that

period the load was again thrown off, and indicator cards taken as before. These cards showed that 27 horsepower was required to overcome friction of the engine and generator when no cylinder oil was being used. Ordinary cylinder stock was then used in the cylinder at the rate of 12 drops a minute for 15 minutes, after which cards were taken, which showed that 24 horsepower was required to overcome friction of engine and generator when imperfectly lubricated. With a better cylinder oil the friction was reduced to 22 horsepower. A return to the high-grade oil for a period of 15 minutes at the rate of 2 drops per minute, resulted in the friction again being reduced to 18 horsepower.

"An object lesson on the necessity of perfect cylinder lubrication can be had with the ordinary duplex boiler feed-pump, as follows: After shutting off the oil supply to the cylinders of these pumps for at least 3 hours, note the number of piston strokes per minute. After lubricating the cylinders freely, again note the number of strokes per minute. The admission of oil will always result in the increased activity of the pump. Oftentimes the number of strokes will be increased from 30 to 50 per cent. This increased speed and increased quantity of water pumped, is due entirely to the reduction of friction of the piston against the cylinder walls, and the valve against the valve face. If an ordinary 15-cent thermometer is placed in a given bearing, and a certain definite quantity of oil used in a given time, the temperature of the bearing noted will give a record of the value of that oil. Another oil can then be used on the same bearing under the same conditions, and the difference in the temperature of the bearing noted.

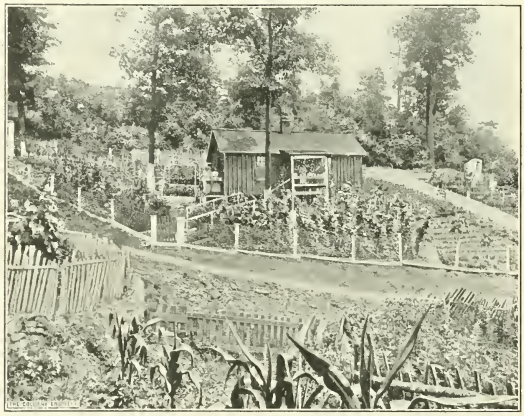
"The best results can usually be obtained by cooperating and permitting the engineer of a reputable manufacturer of lubricants to carefully examine the conditions pertaining to lubrication at the plant, with the plant engineer, bearing in mind always that friction costs more than oil."

Mr. J. Ablett: "Was that oil in the cylinder, 417° flash, and was it cylinder oil?"

Mr. C. H. Garlick: "Yes, it was cylinder oil, and a well-known oil."

Prize Gardens at Weyanoke

Several years ago R. D. Patterson, vice-president and general manager of the Weyanoke Coal and Coke Co., at Weyanoke, W. Va., determined to try to induce his employes to make gardens. As a means to this end he offered a number of cash prizes to be distributed among the owners of the best vegetable gardens, and other prizes for the women having the most attractive flower gardens. The first year the scheme was viewed with suspicion. But after the whole camp had gazed with watering mouths at the succulent lettuce, peas, beans, corn, tomatoes, and other good things raised by the more venturesome, and had seen the prizes in real money distributed, there was no more hesitation. This past year every head of a family in the village, with two exceptions, had a garden sufficient to supply the table with fresh vegetables throughout the season, and a fine display of flowers. The vegetable crop this year was valued by E. A. Schubert, Industrial Agent of the Norfolk and Western Railway, who is versed in such matters, at $4,000. Add the $110 prize money distributed among the best ten gardens and the $750 at which the annual product of the cows, pigs, and chickens owned by the miners is valued, and it totals $4,860 extra money for the village, which gives an average of $21.50 for the 225 men on the pay roll.



Prize Winning Garden at Weyanoke, W. Va.

When the company held its fifth Annual Prize Contest, July last, two of the three judges who had acted in the same capacity the year before were greatly impressed with the increased number of contestants for prizes and with the betterment of the sanitation of the houses and surroundings.

This is what the company gets out of it:

1. A steady, reliable labor supply. Many of the men have been at Weyanoke ever since the mines were opened. Later arrivals are glad to settle down permanently. The man who will raise a garden is likely to be industrious, so the company produces more coal per capita, which means a smaller investment in the plant.

2. An orderly camp. Formerly blind tigers, gambling dens, and other plague spots flourished on the outskirts of Weyanoke and neighboring towns. There was much drinking and fighting and a killing about every week. Now Weyanoke is a model of decorum.

3. A contented community. Men who devote their spare hours to raising gardens have no time to work out grievances with their neighbors or to listen to agitators.

4. Weyanoke is one huge flower garden in summer. Flowers not only are conducive to pleasant thoughts but they also stimulate a desire for better things. Weyanoke is clean and healthy; the houses are painted and neat; the gardens are all fenced and the fences are all whitewashed.

5. There is a marked shrinkage in receipts at the store during the summer months because the miners raise the principal part of their subsistence.

Change in Alberta Mining Laws

*By Norman Fraser, M.E.**

The coal mining regulations in Alberta have been subject to various amendments from time to time, and at recent sessions of the Provincial Legislature further amendments have been asked for, both by operators and miners. The Government, therefore, decided to appoint a commission to go thoroughly into the whole question of mining regulations.

This commission consisted of the Chief Inspector of Mines for the Province, the Commissioner of the Western Coal Operators' Association, and the District President of the United Mine Workers of America. The Commission was appointed on February 17, 1912, and brought in its report on January 17, 1913.

On the basis of this report a Mines Bill was brought into the Legislature, and after debate and further amendment was passed and assented to by the Lieutenant Governor on March 25, 1913, and came into force on August 1 of the same year. The new act is known as "The Mines Act," and is an improvement on the old act, the subject matter being better arranged and the regulations tending toward greater safety in coal mining.

The old act had become unwieldy and hard to follow on account of amendments and new regulations being added from time to time, greatly interfering with the natural sequence of the sections. The Mines Act aims at grouping the various sections of the act, so that all the regulations affecting any particular thing are together. Embodied with the act is an index by which any regulation is easily found.

The act includes an "8-hour from bank to bank" clause, a "bimonthly pay" clause, and makes the erection of wash houses compulsory where more than 20 men are employed. Boys under 16 years of age are not allowed to work underground, and the minimum amount of air required has been increased from 100 to 200 cubic feet per minute.

A copy of the act has to be posted at the entrance to every mine, together with the name and address of the chief and district mine inspector, and the name of the owner and manager of the mine. Copies of all reports required under the act have to be posted at the mine mouth, likewise a plan of the workings up to date within 3 months previous. All coal must be properly mined before shooting, and a record of all misshots made in a book to be kept at the mine for the purpose.

Detonators must be under the control of the manager or some person authorized by him in writing and shall only be given to shot lighters or other persons authorized by the manager in writing.

Under the old act, only mines where inflammable gas had been found were inspected before the commencement of work. Now all mines have to be examined before the commencement of work by a certified examiner in the case of gaseous mines and by any competent person in the case of non-gaseous mines.

Up to the coming into force of this new act, each mine had a set of special rules made in pursuance of the old act for the guidance of employes. Now a code of special rules has been drawn up covering the duties of all classes of employes and the same introduced as part of the Mines Act itself.

The height, width, depth, and distance apart of manholes are clearly defined and all manholes must be whitewashed.

Provision is made for the appointment of examination boards and examiners to conduct the examination of candidates for certificates of competency under the Mines Act in various districts in the Province. Provision is also made for granting of Alberta certificates in exchange for certificates from other Canadian provinces and from other countries under certain conditions.

Coal mining is as yet in its infancy in Alberta, so that the new act comes into force at a very opportune time. The mining industry is making rapid strides, and the output of coal has increased from 1,800,000 tons in 1908 to 4,250,000 in 1913 (estimated), and as railway development increases throughout the country the rate of increase will be much more rapid.

Automatic Mine Door at Seneca

An automatic mine door, operated by electricity, perhaps the first of its kind ever built, was recently installed in the main motor road of the Phoenix and Columbia section, about 2,000 feet from the foot of the shaft at Seneca colliery, near Pittston, Pa., and is working successfully. It was described in *The Employes Magazine* of the Lehigh Valley Coal Co. This mine door no longer requires an attendant, consequently the possibility of accidents due to carelessness, oversight or other human weaknesses, is entirely eliminated. The whole operating mechanism rests on a piece of sheet iron fastened to two wrought-iron pipes 6 inches in diameter, standing upright about 4 or 5 feet to one side of the track. These pipes also act as a roof support. The apparatus consists of two single

*Consulting Mining Engineer, Edmonton, Alberta, Canada.

knife switches; a 2½-horsepower General Electric cable reel, vertical motor *A*, connected by a set of bevel gears to two horizontal, cast-iron, cylindrical drums *B*, a rheostat *C*, an electromagnet *D*, and a 15-pound counterbalance weight *E*. The switches, motor, rheostat, and magnet are all connected in series, and the whole connected on to the trolley circuit. The switches are located on the ribs about 300 feet each side of the door.

Two lamps are hung from the roof of the gangway on each side of the door, so that when it is closed, only two lights can be seen; but, when it is open, all four lights are plainly visible. Thus the motorman can easily tell from the distance whether the door is open or shut.

On approaching the door, if closed, the motorman throws on the switch, which is in easy reach, and the small motor at the door begins revolving. A 4½-inch spur gear *F* on the end of the armature shaft drives an 11-inch wheel *G*, which, in turn through a set of 4-inch bevels, causes the two cylindrical drums, about 3 inches in diameter, to rotate. On one of these drums is wound the

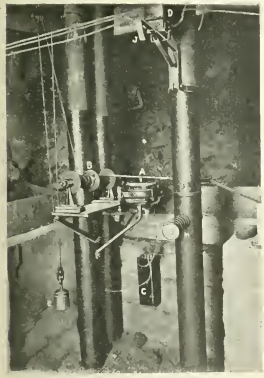


Fig. 2. Operating Mechanism

rope that is attached to the door, pulling it open, while the other drum takes up a rope attached to the weight. The weight acts as a retarder in opening the door and as an accelerator when the door is released to swing shut.

Attached to a third wrought-iron pipe, close by the other two, is an electromagnet about on the level with the top of the door. Should the current, for any reason, cease flowing while the train is going through the doorway, this magnet would release a hook *J*, which would catch the top of the door and hold it until the current came on again.

On this third post and about 3 feet up from the bottom of the door is a heavy spring buffer *H*, which acts as a cushion when the door strikes it in opening, and which assists in closing the door when the current is shut off. On reaching the second switch, the motorman pulls it open; thus shutting off the current from the small motor and releasing the door. The operation is repeated in the same manner on the return trip. There is only one electric locomotive on this road, making on an average six trips a day in each direction.

The door is built of yellow pine, and is 7 feet high by 8 feet wide. The current flowing through the small motor is about 8 amperes direct current, at 250 volts. It is of such design that it can be in service continuously without burning up.

Aside from the safety point of view, the operating economy is also a feature well worth considering. The depreciation and maintenance costs, etc., of this entire apparatus are about 1 cent per day, and the cost of current consumed by the motor is not over 9 cents a day, making the total for operating this door per day not over 10 cents.

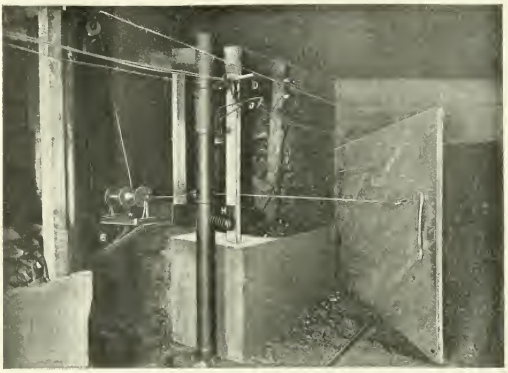


Fig. 1. Automatic Mine Door

Thomas O'Brien, general inside foreman of Seneca colliery, conceived the idea of this door, which was built under the direct supervision of Harry Gilford, inside electrician at the Seneca.

1912 Coal and Coke Productions

Utah mined 3,016,149 short tons valued at $5,046,451, an increase of 502,974 tons over the 1911 output.

Ohio mined 34,524,727 short tons valued at $37,079,573, an increase of 3,764,741 tons over 1911.

Colorado, the most important coal producing state west of the Mississippi River, ranks seventh with 10,977,824 short tons for 1912, valued at $16,345,336, an increase of 820,441 tons over 1911.

New Mexico mined 3,536,824 short tons valued at $5,037,051, an increase of 388,666 tons over the 1911 production.

Mine Accounting

Items Which May Be Capitalized—Those Which Should Be Charged to Operations—What Makes Up Cost of Mining

*By J. B. L. Hornblower**

INTEREST on capital invested in lands, mining rights, plants, and their equipments, and discount on bond issues, should not be charged to mining cost. Interest on bonds sold for the purpose of constructing specific plants is commonly charged to such construction cost up to the time when the plants are ready for operation, but this practice easily runs into an abuse and misrepresentation to bondholders, stockholders, and the public. An operating company will not err, but rather commend itself to all concerned, by holding to an absolute rule not to capitalize interest under any circumstances.

Many companies in the past, that sold bonds for less than face value, charged such discount to Property or Construction Account, but this practice is now less common in companies that wish to be credited with conservative management and frankness in reports to stockholders.

Taxes in an operating company should be charged to Operations, never to Property. The amount of tax chargeable to the operation of a given mine ought to be the tax upon the land which will ultimately be operated through that mine, and the tax for a given year should be apportioned in equal amounts over the divisions of the year for which cost statements are made.

The value of coal or mineral rights, at cost, should be extinguished by charging Operations a fixed amount per ton or per acre as the property is exhausted. Some companies have revalued lands on their books and so created a surplus. This, is unwise. Assuming that the transaction was properly shown on the books of the company as a surplus not derived from operations, and properly followed up by increased charges to future operations for exhaustion, it will appear in the last analysis to be simply reaching into the future. While such revaluation in some cases may seem to be justified, in most cases it ought not to be done. If the lands are worth more than their first cost, the fact will be reflected in increased selling value of the product, which, will increase earnings. The difference of value, believed to exist, ought not to be put into Surplus Account in advance of actual sales of product, as it increases in a fictitious way the mining cost of the future—in other words, it is always wiser to book earnings as they are realized, rather than to anticipate them.

There is, perhaps, no single phase of mine accounting more complex or troublesome, than that of Plant and Equipment Depreciation; and hence nothing in which there are more differences of opinion and methods of procedure among operating companies; and nothing in which managements and accountants may more easily, and with the best intentions, be deceived. The views, herein set forth are, therefore, not necessarily standard—they are the result of personal study and experience.

Up to the time when a mine is ready to produce the daily tonnage for which its development, plant, and equipment were planned (regardless of what it actually does produce, determined by demand, labor, weather conditions, or car supply) all expenditures for development, plant and equipment should be charged to Construction Account and credited by product sold in the full sum realized. After developments have been completed and the mine placed on an operating basis, all expenditures for improvements, developments, or anything that is installed, should be charged to Operations, unless such expenditures increase capacity, in which case they may be charged to Capital Investment with a proper regard to the question of the length of time that such additions may reasonably be expected to serve.

Further charges should be made to Mining Cost monthly in fixed uniform amounts, with credit to a Fund Account generally known as Plant and Equipment Depreciation Fund, for the replacement of capital originally invested in Development, Plant and Equipment, or for the replacement of units which wear out or become obsolete. The extent to which this fund may be used for replacements or renewals in kind must be determined by the rate at which the fund is accumulated. If the rate is low and a long period, perhaps the entire life of the mine, is consumed in charging Operations with the full amount of the original investment (less salvage), obviously no replacements or renewals should be charged against or paid out of the fund—all must be charged to Operations. If the rate be made high enough so that a much shorter period is consumed in getting into the fund the full value of the original investment through charges to Operations, certain replacements, renewals, or improvements may be charged against the fund.

The Pittsburg Coal Co. charges Operations with depreciation of plant and equipment at the rate of 6 per cent. per annum on net (or reducing) values, with credit to Depreciation Fund. This will convey into the fund about 70 per cent. of the original value in 20 years; it is contemplated that salvage values, that is, the values of all equipment scrapped, or removed for use to other points during that period, together with the remainder value, credited to the fund will make up the 30 per cent. or balance of original value not charged to Operations in the fixed monthly charges.

Renewals or replacements are not charged against the Depreciation Fund accumulation, but are charged to Operations; when the charges are so large as to seriously impair monthly comparisons of cost, they are spread over the operations of a few months.

*Read at the American Mining Congress, October, 1913, by J. B. L. Hornblower, Comptroller of Pittsburg Coal Co., Pittsburg, Pa.

In the Pittsburg coal mining district, labor costs fall into two general divisions, first, that which is paid on a unit basis of work performed, such as the scale rate for pick mining, machine mining subdivided into cutting and loading, and dead work, such as yardage, room turning, breakthroughs, clay veins, etc.; and second, that which is paid on a per diem basis, such as motormen, drivers, general inside labor, tipple labor, general outside labor, electricians, etc. The subdivisions of labor differ with changing conditions and according to the viewpoint of the respective operators.

All expenditures for live stock and supplies, after the initial installation at a new mine, should be charged to Operations, as made, although, for purposes of checking, and accuracy in monthly comparisons of cost, inventories should be taken at the close of each month and entries made debiting Inventory Account, with credit to Operations, for unused supplies at cost and for live stock in the service at a fair valuation, taking to account wear and tear.

The mining cost statement at a mine depending upon its own power plant, which does not include a charge for coal consumed, is incomplete and misleading in comparison with mines purchasing power from central stations. For this reason it is proper to charge the fuel at a representative value to Operations, with credit to Coal Sales Account, notwithstanding that Operations have already been charged with all the items entering into the cost of the product so consumed. This treatment of the individual power plant fuel of course, must not be lost sight of in the general summary of business done.

Fire, tornado, boiler, and employer's liability insurance premiums are increasingly important as items to be taken to account in mining costs, whether these hazards are covered by insurance companies or assumed by the operator. In the latter case a fund or funds should be created and maintained at a charge to Operations in sufficient amount to pay all losses, and, conservatism suggests, to accumulate a reasonable surplus.

General office expenses and other general expenses should be incorporated in mining cost statements in order to get a total outside cost upon which to base selling values; they should, however, be shown separately under appropriate headings, and not included in any of the subdivisions of "Cost at Mine." In a company conducted exclusively as a mining company it is, perhaps, better not to differentiate nicely between that portion of general office expense which is chargeable direct to mining, such as the operating and engineering departments, and the expenses of the department of sales, transportation, finance, accounts, etc. In a broad sense, the base of all the company's business is the production of its mines, hence all of its general office expenses may properly be included as a part of its total mining cost.

Cost Statement of a Bituminous Mine in the Pittsburg District

	Operating Days	
Production in tons of run of mine		Tons
1¼-inch lump		%
Small sizes		%
Total		%
Picked mined		%
Machine mined		%
Total		%
Cost Per Ton		$
Pick mining		
Machine mining		
Yardage		
Room turning		
Breakthrough		
Clay veins, spars, etc.		
Drainage and ventilation		
Animal haulage		
Mechanical haulage		
General inside labor		
Tipple labor		
General outside labor		
Supt., clerks, pit and fire bosses		
Mining machine repairs		
Mining machine expense		
Pit car repairs		
Pit rails and ties		
Pit posts and caps		
"T" iron and spikes		
Power plant expense		
Stable expense		
General expense at mine		
General repairs		
Total direct charges		=
Labor		$
Supplies		
Fuel		
Royalty		
Depreciation		
Taxes, insurance, and other general expense		
General office expense		
Total		$

Hard and Soft Water

Hard water contains alkalies, and curdles soap. Soft water is free from mineral salts that curdle soap.

The Selection of Coke Samples

*By Fred C. Keighley**

The sampling of coke has always been a source of annoyance, in fact, has often caused dissensions between the manufacturer and the consumer of coke. The trouble arises from the seeming impossibility of getting two sets of analyses to agree. To the average coke maker it seems unreasonable for the iron smelter to reject coke on account of .001 or .002 of 1 per cent. of phosphorus, when the coke is first class in every other respect.

I have been connected with coke manufacturing operations for over 30 years and nothing ever caused a sinking of my heart and the changing of my complexion as much as that term "phosphorus," when it appeared in my morning's mail. I once lost a good position by reason of a difference of opinion as to the cause of the phosphorus barometer taking a trip of a couple of one-thousandths of 1 per cent. in altitude.

My superior officer said: "The phosphorus in your coke is positively abominable," and I heartily agreed with him, but when he accused me of being the cause of phosphorus in the coke, my temperature arose.

The facts were that up to this particular time the coke had managed to keep a little shy of .02 *P*. Then it suddenly went to .022 *P* with an occasional naughty behavior of .03, as .02 *P* is the limit of decorum in a Bessemer "cokequette" and flirting with fractions of thousandths of 1 per cent. above that is simply scandalous. At that time the superintendent of a coke works did not know the constituents of the coal mined daily. All he knew was that the resulting coke had a good or a vile behavior record. Such a thing as sampling coke and coal regularly was considered an extravagance not to be tolerated. The iron smelter cut such capers, but only when his furnace got the stomach trouble and

*General Superintendent, Oliver & Snyder Steel Co. An abstract of the paper read at the December, 1913, meeting of the Coal Mining Institute of America.

failed to deliver the correct thing in the pig bed.

It was discovered some months after my resignation that a fault crossed the coal field and the high phosphorus in the coal was in some way due to the near presence of that fault. Many of us have phosphorus troubles in spite of the better facilities now afforded to ascertain the chemical constituents of the coke and the coal. Large coke producers now have a chemist to look after troubles of this kind, and thus assist the management in keeping tabs on the phosphorus. No matter how skilful a chemist may be or how experienced, he cannot lay his finger on phosphorus and tell you where it came from; however, he can say where it invariably goes when it gets associated with the contents of a blast furnace. There is as yet no known way of reducing phosphorus in either coal or coke, and about the only thing that can be done is to sample both the coal and the coke regularly and carefully and have them analyzed. There will be differences in the analyses of the different chemists on the same samples, but with care the phosphorus should not vary more than from one- to three-thousandths per cent. After much thinking, I have about come to the conclusion that where the chemists are far apart in their phosphorus determinations in coke or coal, that in all probability the method of taking the sample and its preparation for analysis is the cause of the variations.

A short time ago my attention was called to one plant that had suddenly developed into a high phosphorus coke producer. Remembering past experience, I concluded to sample the coal, and found that in a certain section of the mine where the pillars were being taken out, the coal analyses gave .077 in phosphorus, which is equivalent to .115 phosphorus in the coke. A short distance away from this place the phosphorus in the coal was .04 or .06 in the coke. The phosphorus showing in a sample of coke is generally about one-half higher than that in the coal from which it is made. Having caught the culprit in the mine, a series of samples taken in order westward gave the following percentage analyses for phosphorus: .032, .029, .021, .021, .012, .011, .011, .010, .009, .009, .008, .006, .006, .006, .005, .005.

Speculations on the law governing this diminution in phosphorus in the coal is uncertain, although it certainly was a great relief that the high phosphorus coal existed only in a very small portion of the mine territory, yet the coke analyses were not so satisfactory as the small quantity of high phosphorus coal would lead one to expect. In view of this the next thing was to follow up the coke sampling.

When the difficulty first appeared the coke cars were sampled as follows: A typical piece of coke was taken at one end of the car, another one was taken from the middle and a third from the remaining end of the car while it was being loaded. These three samples from each car, which made a bulky pile when any considerable number of cars were sampled, were reduced by hand to a general sample. This did not bring the expected results. Full length samples were then taken from every oven at three different points and again reduced to general samples. Still there was trouble. Finally, samples were taken in each oven at several points designated on a blueprint showing a horizontal section of the whole oven divided into three concentric circles of equal area. Samples were taken in such number and such points as to give a fairly accurate average sample of the output of the ovens under observation. This was the best method so far, but still things did not seem to gee just as they should. By this time I was becoming convinced that the method of gathering and the division of the samples for procuring a general average sample of the coke was largely responsible for the difficulty. A friend suggested that a "Chipmunk" crusher was a good thing to use in connection with sampling the coke. A Chipmunk crusher was installed and the results were encouraging, in fact, the crusher nearly eliminated the trouble.

I believe that the bulk of the phosphorus trouble came through the poor methods of sampling and the lack of knowledge as to the best method to be adopted in that connection.

Perhaps it would be well to state that this paper was written principally from a Bessemer-coke standpoint, i. e., on coke that was intended to be used in making Bessemer pig iron. In the case of pig iron that is to be refined by the basic process, phosphorus is not so serious a matter, as that element is taken care of in the open-hearth furnace; however there is a limit to the percentage of phosphorus that can be tolerated even there.

New Houses for Miners

The work of improving the housing conditions of the miners in the Fairmont field is progressing rapidly. The construction of ten or more houses for families of employes of the Hutchinson Coal Co. was completed recently at Reynoldsville and Mt. Clare at a cost of little more than $12,000.

M. L. Hutchinson, the president of the Hutchinson Coal Co., gave particular attention to planning and building these houses, after studying the special needs of his employes. They are frame houses of five and seven rooms, two stories high, and all have large porches. They will be lighted by electricity and the plumbing will compare favorably with that in houses that cost much more money.

The Consolidation Coal Co. has put up houses at Viropa, Glen Falls, and Lost Creek, and F. R. Lyons, general manager of operations, says that the erection of new houses at other points is planned. None of these houses will cost less than $1,000 and the cost of many will run as high as $1,500.

Dawson, New Mexico, Mine Disaster

Disobedience of Specific Rules for Shot Firing by an Employe, Which was also a Violation of the State Mine Law, the Cause

Written for The Colliery Engineer

THE No. 2 mine of the Stag Cañon Fuel Co., at Dawson, N. Mex., was, on October 22, the scene of one of the greatest coal mine disasters in American mining history. To those who had any knowledge of the character of the mine, and the precautions taken to conserve the lives of the employes, the news, when chronicled in the daily papers, seemed incredible. In fact, the writer, at first, believed that it was greatly exaggerated. The explosion occurred at 2:55 P. M., and the total loss of life was 261.

A detailed illustrated description of the property and operations of the Stag Cañon Fuel Co., by Jo. E. Sheridan, former Territorial Mine Inspector, will be found in the June, 1911, issue of this journal, and on pages 354 to 381, inclusive, of Vol. XL, Transactions of the American Institute of Mining Engineers. From Mr. Sheridan's paper we abstract the following general points:

The mines are located in the northern part of New Mexico, somewhat east of the center. They are in part of the southern end of the Raton coal field, which extends north into Colorado and embraces many coal camps of the Trinidad section.

Geologically, the coal measures, commonly known as the Laramie series of the Cretaceous system, have a thickness of about 800 feet at Dawson. There are two workable seams in the coal measures, and the Dawson mines work the lower of the two, which is known as the Raton or Blossburg seam. This seam varies from 6 to 11 feet in thickness, with an average thickness of at least 7 feet.

The coal carries in its composition from 32.25 to 45.69 per cent. of volatile hydrocarbons, and from 45.08 to 60.5 per cent. of fixed carbon. An average of mine samples, analyzed by the United States Geological Survey, shows 38.2 per cent. volatile hydrocarbons, 50.65 per cent. of fixed carbon, 10.34 per cent. ash, and 8 per cent. moisture. The coal does not air slack.

The mines are opened by drift entries. The system of mining employed is by triple main entries, room and pillar, and robbing, on retreat, when the district becomes exhausted. The width of main and cross-entries and air-courses is 9 feet; the height of air-courses, 6 feet 6 inches; the height of roads, 6 feet; room necks, 20 feet; average width of rooms, 24 feet; average length of rooms, 350 feet; distance of room centers, 50 feet.

The accompanying map on a scale of 800 feet per inch, shows the workings of No. 2 mine.

The ventilation of the mine is effected by a Jeffrey fan with a capacity of 200,000 cubic feet of air per minute, with a 2-inch water gauge, or 400,000 cubic feet per minute with an 8-inch water gauge. The exhaust steam is used, and air being drawn into the mine at the main openings, and distributed through the workings by a number of splits, finally being exhausted at the fan. Occasionally some gas was found in the mine, but not enough to class it as a "gaseous mine." To guard against gas and dust, the company's chemist frequently takes samples of air in remote parts of the workings and gobs, and makes determinations of their chemical constituents, and the quantity of dust in suspension.

Competent fire bosses, under the immediate supervision of the mine inspector, make daily tests for gases with safety lamps. As will be seen by the map, there are four exits from the mine—the air-shaft, manway, and two haulageways.

The mine is equipped with a telephone system, with water pipes and a complete spraying system for humidifying the mine air. Rescue corps, equipped with helmets and other apparatus, and first-aid teams are also maintained. In mining, the coal is undercut. About two-thirds of the undercutting is done by hand and one-third by Sullivan and Goodman machines. Permissible powders, Monobel No. 2 and No. 5 only are used in shot firing.

Electricity is used for running the mining machines, for haulage and lighting main entries.

The general rules formulated by the company for the government of its employes are specific, well considered, and if strictly obeyed, would practically remove all danger.

The system of shot firing employed at the mine is remarkable for its safety provisions. All shots are fired by electricity and the rules require that the firing must only be done after all the men are checked out of the mine. As the men enter the mine they are required to deposit a metal check at the shot firing house outside, near the entrance. These checks are placed on a checkboard and are returned to the men as they come from the mine. A record of the working place of each check number is kept in the shot firing house, and in case any check is uncalled for before shot firing time, the shot firer makes a search for the man until he is found. No shots are fired until it is known positively that no one is in the mine.

At 3 P. M. each working day, the shot inspectors enter the mine with the detonating caps, distribute them to the miners and later connect the wires. The wires for each entry are equipped with a separate switch enclosed in a box. These switches are kept locked until all the men are checked out of the mine. The shot inspectors, when satisfied all the men are out of the mine, close all these switches, on the way, as they proceed to the surface. Finally, when it is absolutely certain that all the men are out of the mine the main

switch at the mine entrance is closed. This completes the entire circuit and all the shots are fired instantaneously.

Immediately after the firing, the shot inspectors proceed into the mine with safety lamps and note if there is any fire, or whether there are any missed holes, broken timbers, extensive falls, etc. Their observations are reported to the mine foreman, and, if necessary, proper precautions are taken. It was a departure from this method and a gross violation of the rules of the company and of the mine laws of New Mexico by an employe, one of the victims, that caused the disaster.

Mr. Rees H. Beddow, State Mine Inspector, who made a careful personal examination of the mines, reported as follows:

"The explosion was caused by an over-charged shot, being fired in room No. 27, off the ninth west entry in mine No. 2. This is shown on the map at *A*. This shot blew the coal out into the gob for a distance of 40 feet, creating much wind, stirring up and igniting the coal dust, spreading from this point to all points of the mine. The shot firing wires were traced from the shot back to the first cross-cut between rooms Nos. 27 and 26; it then turned out room No. 26 to within 50 feet of the ninth west entry, where it was attached to a cut-in. The wire then led out of room No. 26 into the ninth west entry to room No. 24, where it was connected to the switch, convenient to the trolley wire. This switch was also cut in. A piece of copper wire was found wrapped around the trolley wire opposite this switch and a piece of shooting wire, the right length to connect the switch with the trolley wire, was found on top of a loaded car standing between the switch and the wire that was wrapped around the trolley; also an electric detonator was found on the floor near this switch, thus showing that this shot had been fired from the trolley wire."

Why any sane man would go to the trouble of attempting to surreptitiously fire a shot in such an irregular way, is past comprehension, but the history of great mine disasters shows that in most instances some reckless act or some piece of foolishness made a normally safe mine the scene of a great and unnecessary disaster.

At the time of the explosion there were 284 men in the mine, of whom 261 were killed. Most of them, aside from officials, were Italians. Nearly all of the victims were instantly killed by the explosion, but few bodies having been found under falls. From 10 to 14 were probably asphyxiated by afterdamp.

Immediately after the explosion, a helmet corps entered the mine. Before the fan could be started they had explored the seventh west entry of the *HI* line (see *E* on map), and proceeded as far as the air-shaft (see point *C* on map). As the explosion doors were blown off and the air-course leading to the fan was damaged, it was half an hour after the explosion, or 4:25 P. M., before the fan could be started.

Owing to distance necessarily traveled, it was 18 hours after the explosion when the United States Bureau of Mines helmet men arrived at the mine. These men and the officials and the employes of the Colorado and New Mexico coal companies, who hastened to the mine, rendered valuable service and greatly assisted the officials of the Stag Cañon Fuel Co. in the rescue work, and Mr. T. H. O'Brien, general manager of the company, has requested us to express publicly in this connection the thanks and the appreciation of the officials of the company for the assistance given and courtesies extended in this time of trouble.

Immediately after the explosion, one minor fire was discovered in the mine, and it was quickly extinguished with water. Some time later another was discovered, which was extinguished by water and fire extinguishers. Two of the helmet men connected with the rescue corps were killed, but the exact circumstances under which they were overcome are not known.

The only places in the mine where men were found alive and rescued were in the thirteenth and fourteenth east entries of the *HI* line, shown on map at *D*.

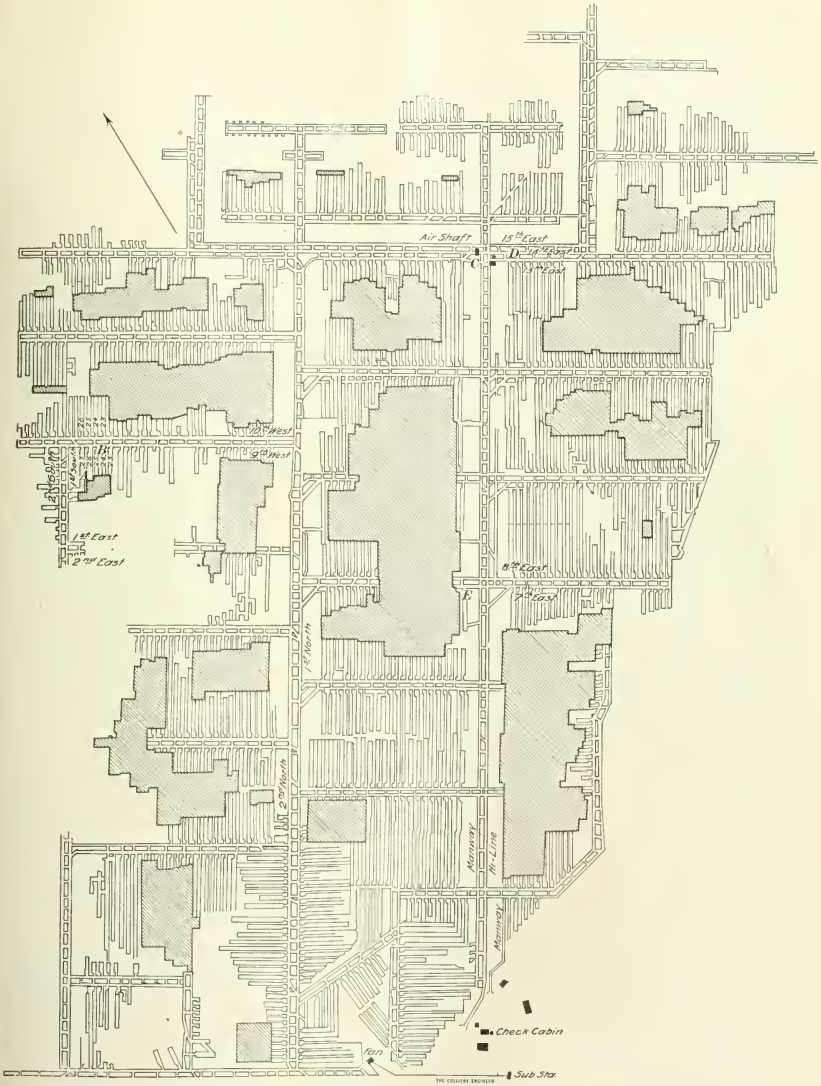
The coroner's jury inquiring into the cause of the accident, after hearing the testimony of a number of witnesses including State Mine Inspector Beddow, Jo. E. Sheridan, formerly United States Mine Inspector for New Mexico, T. H. O'Brien, manager of the company, and other mine officials, went into the mine and proceeded to pillar No. 27 in ninth west entry (see *A* on map), to make a personal examination of conditions described by Mr. Beddow. Returning to the surface they again went into session, and rendered a verdict to the effect that the explosion, resulting in the loss of 261 lives, was caused by an employe of the company unlawfully firing a shot while the full shift of men was in the mine.

Combustion in High Altitudes

In high altitudes it is difficult to cook beans or vegetables, as water boils at a lower temperature than at sea level. At altitudes so high as 14,000 feet there is difficulty in kindling a fire, and any burning material has a tendency to go out, the same as a burning stick when placed in a jar. The reasons advanced for these phenomena are that a cubic foot of air at 14,000 feet elevation contains only about 60 per cent. of the oxygen that a cubic foot of air contains at sea level. Persons accustomed to living at sea level cannot exercise freely in Denver without quick loss of breath, until accustomed to the rarefied atmosphere.

Correction

The paper on "Cost of Mining as Related to Output," which appeared in our October issue, was by L. C. Jones, Vice-President of the Solvay Collieries Co., and not by R. C. Jones.



Plan of the Workings of the Stag Cañon Fuel Co.'s Mine No. 2. Scale, 1 in. = 800 Ft.

The Clinkering of Mixed Coals

At High Temperature—Experiments Showing that Coals Which of Themselves May not Clinker, May do so When Mixed

*By R. D. Quickel, E. M.**

THE object of this paper is to call attention to some few facts, relative to the combustion of mixed coals, the satisfactory results sometimes experienced when burning them, the reason for the unsatisfactory results, and an attempt to formulate some rules whereby we may find out before using any one coal, or a mixture of coals, whether or not clinkering will result when the coal or coals are burned in a locomotive firebox.

The locomotive firebox has been used in the practical and theoretical work connected with this paper, because a locomotive under maximum working conditions generates temperatures higher than are probably generated in any other common combustion chamber.

As to the clinkering of coals, the very newest textbooks mention that such a thing occurs, but give no reasons as to the actual cause, although some of them do mention that the ash may have something to do with it.

Every user of steam coal has discovered, to his sorrow, coals which would not give him satisfactory results, and large consumers have also discovered that they could not use a mixture of certain coals. In all cases the results were only discovered after an immense amount of trouble was experienced. These errors in purchasing fuel are not only extremely annoying, but are also very expensive. The fuel purchasing department of the Queen & Crescent Route discovered years ago that it was impracticable to mix certain coals together and get satisfactory results, and that it was necessary to run actual locomotive tests with the mixed fuel to find out if the mixed fuel would give maximum steam pressure when burned on their various locomotives. For instance, we draw our present fuel supply for the Cincinnati, New Orleans & Texas Pacific Railway from four separate and distinct districts. From three of these districts we can, and do, mix the coal indiscriminately on our coal chutes for locomotive fuel, while the coal from the fourth district will not burn without clinkering, if mixed with any of the other coals from the three districts mentioned; in other words, if we were to come to a coaling station with about half a tank of fuel from the fourth district, and were to fill the tender with coal from any one of the other three districts, we would shortly have clinker trouble and engine failure.

With our present equipment we have found that sometimes either one of two coals would be absolutely satisfactory when used by itself, but when mixed, these same two coals would prove absolutely unsatisfactory. We have also found that sometimes certain mixed coals will give perfect satisfaction in our stationary boiler plants, but when used on a locomotive prove themselves to be an absolute failure.

As previously stated, actual experience on locomotives has shown that certain coals, or certain mixtures of coals will clinker. If we can find any simple method of determining by calculation from a true analysis, involving both proximate analysis of the coal and the ash analysis, whether a coal will or will not clinker, we have discovered something which should be of help, both to the coal dealer himself, and the man who buys coal. It has been the writer's experience that a great many coal salesmen fool themselves in regard to their own coal. Today, when a steam coal must stand on its merits with regard to contract based on British thermal units, and ash and sulphur content, a coal salesman cannot know too much about the product he is trying to sell. A contract let through misrepresentation or ignorance, works, in the writer's mind, a greater hardship on the seller, eventually, than it does on the buyer, on account of the bad reputation given the coal and those who sell it, when it does not serve the purpose for which it was sold. If a man can tell for what purpose his coal will give satisfaction, he will not blindly contract to do something which he knows he cannot fill. Different kinds of coals are not all suited for the same purpose, a great deal depending on the draft, grates, and temperatures reached in the various combustion chambers.

KINDS OF CLINKER

There are two separate and distinct kinds of clinkers formed in locomotive operation; one, namely, the hard clinker, is formed largely by improper firing; the other, known as the molasses clinker, is formed by the fusing together, or slagging, of the coal ash. Improper firing can never be directly responsible for the formation of a molasses clinker, but will undoubtedly hasten its formation. The hard and the molasses clinkers differ widely in chemical composition, as is shown in Table 1.

Table 1. Analyses of Clinkers

	Hard Clinker Per Cent.	Molasses Clinker Per Cent.
Silica	56.50	35.04
Alumina	35.20	17.32
Ferric oxide	4.96	37.12
Lime	.66	7.42
Magnesia	.83	1.12
Potash	1.14	.87
Soda	.43	.63
Sulphur	1.00	trace
Titanium dioxide	trace	.50
Total	100.72	100.02

These two kinds of clinker differ more widely in their formation and action in the firebox than they do in chemical composition. The hard clinker in the firebox gives the firebed, in the spot where it is formed, a dead appearance, which stays approximately the same size as when

*Fuel Agent, Q. & C. route, Lexington, Ky. A paper read before the Kentucky Mining Institute.

first formed. This clinker can be easily gotten rid of by simply pulling it out of the fire, or by turning it upside down, or on its side. After being turned upside down, it is simply disintegrated by the action of the fire. The hard clinker has a tendency to stick together, and will not break when an attempt is made to remove it. The molasses clinker is altogether a different proposition. When first formed, its appearance in the firebox is similar to that of the hard variety, but instead of staying approximately the same size as when first noted, it will continue to grow larger in area. After it has grown in size so as to cover an area of approximately 4 square feet, if examined when the engine is working, or with the blower on, small blue flames about 3 inches in length will be noticed coming up through the clinker and can also be noticed at the edges. This clinker will continue to grow in area until the entire surface of the firebox is covered. Upon attempting to remove this clinker we find a remarkable condition. The clinker will be soft, as compared to the hard clinker, and as fast as we remove the upper part or crust, we find the semi-ash underneath the crust, having run together like thick molasses, hence the name, molasses clinker. Examination of the ash pan and fire-grates is also surprising. The clinker is found to have run down between the grate fingers, and where hardened, hangs from the grate bars in long strings like icicles. Upon attempting to shake the grate we find it impossible, as the clinker has filled the space between the grate bars, and solidified to such an extent as to prevent any chance for motion in the grate fingers. The only way a clinker of this character can be removed is to clean the entire firebox and build a new fire. Of course, in a case of this character we have experienced a very disastrous engine failure.

For any one familiar with metallurgy or the principles thereof, it is very evident that in the formation of a molasses clinker a metallurgical reaction of some kind has taken place.

The writer's attention was first called to the matter of calculating the slags in coal ash by an article in Mines and Minerals, now The Colliery Engineer, by Mr. E. B. Wilson, editor. In this article and a subsequent one written for delivery before the Coal Mining Institute of America, Mr. Wilson advocated the use of Ballenger's factors in connection with the metallurgical conditions which would be involved in figuring slags from the percentages of silica and the various oxides as shown in the ash analysis of a coal. The writer applied these factors in some calculations connected with practical engine tests and found them to give excellent results.

DEFINITION OF MONOSILICATE SLAG

There are, more than likely, three different kinds of silicate slags formed in the fusing together of coal ash at high temperatures. However, as we are certain of the formation of the monosilicate slag, the writer will use the monosilicate slag as typical in the following discussion.

A monosilicate slag is one in which the ratio of the oxygen in the base is to the oxygen in the acid as 1 to 1. For the benefit of those unfamiliar with metallurgical terms and chemical formulas, the following is given as an illustration of a monosilicate slag expressed as a chemical formula. The slag formed in this case, formula for which is shown on the right-hand side of the equation, is known as a calcium monosilicate.

$$\underset{2CaO}{\text{Lime}} + \underset{SiO_2}{\text{Silica}} = \underset{2CaO \cdot SiO_2}{\text{Calcium monosilicate}}$$

It will be noted that because the silica contains two atoms of oxygen as written on the left-hand side of the equation, to make the ratio 1 to 1 we must use two molecules of lime. Similarly we can write the silicate slags of magnesia, alumina, and ferric oxide as follows:

$$\underset{2MgO}{\text{Magnesia}} + \underset{SiO_2}{\text{Silica}} = \underset{2MgO \cdot SiO_2}{\text{Magnesium silicate}}$$

$$\underset{2Al_2O_3}{\text{Alumina}} + \underset{3SiO_2}{\text{Silica}} = \underset{2Al_2O_3 \cdot 3SiO_2}{\text{Aluminum silicate}}$$

$$\underset{2Fe_2O_3}{\text{Ferric oxide}} + \underset{3SiO_2}{\text{Silica}} = \underset{2Fe_2O_3 \cdot 3SiO_2}{\text{Iron silicate}}$$

The molecular weights and symbols of the various atoms involved in the following calculations may be readily gotten from any international table of atomic weights. The ones given below are only those which will be used in the subsequent calculations:

Oxygen = O = 16; magnesium = Mg = 24.36; iron = Fe = 55.9; alumina = Al = 27.1; calcium = Ca = 40.1; silicon = Si = 28.4. Referring back to the equation showing a calcium monosilicate and substituting the atomic weights, we have the following:

$$\underset{112.2}{2CaO} + \underset{60.4}{SiO_2} = \underset{172.6}{2CaO \cdot SiO_2}$$

From this equation it is readily seen that it requires $\frac{60.4}{112.2} = .543$ part of silica to combine with one part of lime to form a calcium monosilicate slag. The decimal fraction .543 is termed Ballenger's factor for a lime silicate. Ballenger's factors for magnesium, iron, and aluminum silicates are determined as follows:

For a magnesium silicate

$$\underset{80.72}{2MgO} + \underset{60.4}{SiO_2} = \underset{141.12}{2MgO \cdot SiO_2}$$

Ballenger's factor equals

$$\frac{60.4}{80.72} = .747$$

For an aluminum silicate

$$\underset{204.4}{2Al_2O_3} + \underset{181.2}{3SiO_2} = \underset{385.6}{2Al_2O_3 \cdot 3SiO_2}$$

Ballenger's factor equals

$$\frac{181.2}{204.4} = .886$$

For an iron silicate (ferric)

$$\underset{319.6}{2Fe_2O_3} + \underset{181.2}{3SiO_2} = \underset{500.8}{2Fe_2O_3 \cdot 3SiO_2}$$

Ballenger's factor equals

$$\frac{181.2}{319.6} = .567$$

Ballenger's factors for the principal oxides found in the coal ash are then as follows: MgO = .747; Al_2O_3 = .886; CaO = .543; Fe_2O_3 = .567.

The proximate analyses of the various sections of the No. 4 Blocton coal, in the Blocton field of Alabama are given in Table 2:

The Blocton coal was used as a locomotive fuel on the Alabama Great Southern Railroad for a pe-

riod of 2½ years, although during its successful performance the fireclay parting was not, to any extent, noticeable in the section of the seam mined during that time. The amount of rash practically amounted to nothing. Upon renewal of contract with the company mining this coal, and after the contract had run for a period of about 6 months, we began to have a great deal of trouble with clinkered fires. The trouble was traced to the coal, analyses given in the table, and further shipments refused. An ordinary examination of the coal on the coal chutes, and in cars, did not show any unusual percentage of incombustibles. Closer examination, however, did show some little fireclay and rash in the product. The owner decided to have this coal washed, and a car was sent to the washer plant and the entire contents washed. The writer personally supervised a test of this washed coal on one of our manifest freight trains, with the following result:

Left Birmingham December 2, 1912, as first section train 77, south, engine 216, with 1,360 net tons freight, thirty loads and one empty; maximum grade encountered for any distance, 1 per cent.; coal washed and screened over a ¾-inch screen. A peculiar thing was noted during this test, in that no matter how the coal was fired it was impossible to make any black smoke. Of course, black smoke is not desirable at any time, but the fact remains that with the majority of coals, having from 25 to 35 per cent. volatile matter, smoke is easier made than eliminated. After the engine had been run about 30 miles it was noticed that there was a slight dropping back in steam pressure, although several times while the engine was in side track at meeting points, the engine popped off. On a grade known locally as Tuscaloosa Hill, about 55 miles from Birmingham, the steam dropped back to 135 pounds, and it was just possible for the engine to pull the train to the top of the hill and roll over into Tuscaloosa. We had a meeting point at Moundville, 15 miles south of Tuscaloosa, and after being on the side track at this point for about 15 minutes, steam pressure dropped back to 45 pounds.

The first clinker of any size was noticed about 40 miles south of Birmingham. This clinker was very small and showed itself to be of the molasses variety. The clinker grew rapidly in area, and when the test train reached Tuscaloosa, the clinker covered the entire area of the firebox. During the entire test, the slice bar was not used one time, and the engine was fired by the most up-to-date method of firing.

At Moundville an attempt was made to clean fire. It was soon discovered that as fast as the clinker was removed, what remained in the firebox ran together again, and it was necessary to knock the fire. The crust of this clinker was approximately 12 inches in thickness. It had been impossible to shake the grates for some time and upon examination of the grates and firebox we found both completely filled with clinker. A microscopical examination of the coal showed that some of the coal was impregnated with small partings of fireclay and rash. It was also found in the sample of coal that there was a small percentage of fireclay and rash. Upon receipt of the foregoing analyses I advised the company mining this coal that I did not believe, from some calculations which I had made, that the coal could be made satisfactory, even by washing, on account of the high percentage of silica and bases which were in the ash, anticipating, of course, that the cleaning of coal on the car and washing, would not, by any means, remove all the fireclay and rash. The fireclay and rash, it will be noted, contain a high percentage of silica, the bases being largely contained in the ash of the coal itself.

Referring to the analyses of both the coal and the ash, it will be noted that, as far as the bases are concerned, we may eliminate practically all of them, except those for which we have already determined Ballenger's factors. The sulphur is reported as sulphur trioxide, and it is probable that some part of it will combine with part of the lime, forming calcium sulphate ($CaSO_4$). Assuming that one-tenth, or 10 per cent. of the SO_3 combines with the lime, we would have available percentages of lime, as follows:

Table 2. Proximate Analyses of Blocton, Ala., Coals

	No. 1 Bottom Coal	No. 2 Fireclay	No. 3 Middle Man	No. 4 Top Coal	No. 5 Rash
Moisture	2.00	.83	.91	1.33	1.35
Volatile combustible	36.03	7.07	24.36	34.71	17.12
Fixed carbon	58.52	.72	55.98	57.16	25.98
Ash	3.45	91.38	18.75	6.80	55.55
Total	100.00	100.00	100.00	100.00	100.00
Sulphur	.76	None	.23	.40	.27
British thermal units	14,150	None	12,405	13,840	*

* Not possible to ignite on six different attempts.

Table 3. Analyses of Ash of Above Coals

	No. 1 Bottom Coal	No. 2 Fireclay	No. 3 Middle Man	No. 4 Top Coal	No. 5 Rash
Silica	11.34	52.32	28.00	20.40	60.42
Ferric oxide	31.84	5.44	12.64	14.80	3.20
Alumina	13.40	24.20	7.82	11.26	30.24
Lime	16.54	.50	26.90	26.66	.72
Magnesia	6.99	1.80	6.93	4.60	.63
Titanium Dioxide / Sulphur Trioxide	17.82	.80	trace	.64	1.10
			2.26	7.97	trace
Potash	.54	4.22	.34	.36	.80
Soda	.48	.35	.51	.35	1.36
Ignition		8.91	15.96	13.12	1.30
Carbonate		trace	much	present	none
Moisture		.83			
Total	99.04	99.37	101.36	100.16	99.77
Fusibility in blast lamp	fusible	fusible	fusible	fusible	infusible

No. 1, Bottom coal, 14.89 per cent.; No. 2, Fireclay, .45 per cent.; No. 3, Middle Man, 24.21 per cent.; No. 4, Top coal, 24.40 per cent.; No. 5, Rash, .65.

As sulphur trioxide is a very unstable compound, the chances are that a large part of it will go off in the ordinary process of combustion. As we have also present some little carbonate and potash, part of the SO_3 may combine with the carbonate and potash, forming sodium sulphate, and potassium sulphate.

Taking the factor for ferric oxide .567 and multiplying it by 11.34, or the percentage of ferric oxide present in the bottom coal, we have:

Fe_2O_3 .567×31.84 = 18.05 per cent. of silica needed to unite with 31.84 per cent. FeO.

Similarly,

CaO .543×14.89 = 8.08 per cent. of silica needed to unite with 14.89 per cent. CaO.

Al_2O_3 .886×13.40 = 11.87 per cent. of silica needed to unite with 13.40 per cent. AlO.

MgO .747× 6.99 = 5.22 per cent. of silica needed to unite with 6.99 per cent. MgO.

42.22 per cent. of silica needed to unite with bases present.
11.34 per cent. of silica present in bottom coal.

30.88 per cent. of silica needed.

Performing similar calculations for the Fireclay:

Fe_2O_3 .567× 5.44 = 3.08 per cent.
CaO .543× .50 = .27 per cent.
Al_2O_3 .886×24.20 = 21.33 per cent.
MgO .747× 1.80 = 1.34 per cent.

26.02 per cent. of silica needed to unite with bases present.
52.32 per cent. of silica present in fireclay.

26.30 per cent. of silica in excess of bases.

For Middle Man:

Fe_2O_3 .567×12.64 = 7.16 per cent.
CaO .543×24.21 = 13.15 per cent.
Al_2O_3 .886× 7.82 = 6.92 per cent.
MgO .747× 6.93 = 5.18 per cent.

32.41 per cent. of silica needed to unite with bases present.
28.00 per cent. of silica in Middle Man.

4.41 per cent. of silica needed.

For Top coal

Fe_2O_3 .567×14.80 = 8.39 per cent.
CaO .543×24.40 = 13.24 per cent.
Al_2O_3 .886×11.26 = 9.97 per cent.
MgO .747× 4.60 = 3.43 per cent.

25.03 per cent. of silica needed to unite with bases present.
20.40 per cent. of silica present.

14.63 per cent. of silica needed.

For rash

Fe_2O_3 .567× 3.20 = 1.81 per cent.
CaO .543× .65 = .35 per cent.
Al_2O_3 .886×30.24 = 26.79 per cent.
MgO .747× .63 = .47 per cent.

29.72 per cent. of silica needed to unite with bases present
60.42 per cent. of silica present in rash.

30.70 per cent. of silica in excess of bases.

By referring to the above calculations, an excessive amount of bases will be noted in all but the fireclay and rash, each of which show silica to be largely in excess, and which would combine with the excess of bases in the bottom coal, Middle Man, and Top coal. Please note also chemist's notes in the analysis of the ash, to the effect that in a simple laboratory blast lamp, all but the rash were fusible.

The writer desires to state here that while this coal did not give satisfaction on locomotives, it did give excellent results as a power-house fuel, the reason no doubt being that the temperature reached in the power-house boiler, where it is now being used, is not near so high as that reached under maximum working conditions on a locomotive. On account of the various horizons in the coal bed from which the above sample was taken, it may be taken as a fair sample of a mixed fuel. The writer has under investigation, at present, some other samples of coal, but as the ash analyses have not been completed, he is unable to give them.

A summation of the percentages of silica needed to convert all the basic oxides present in the top coal, Middle Man, and bottom coal, to a monosilicate slag gives us 49.92 per cent. Likewise, we find a total of 57.18 per cent. of silica in excess of that required to convert the basic oxides in the fireclay and rash. Subtracting, we find we have 7.08 per cent. of silica in excess of what is needed. This amount of silica in excess need not be considered, as it would be removed in the preparation of the coal by washing.

One of the markets available for Alaska coal, were the coal fields of the territory developed, would be to supply coke to the smelters and foundries on Puget Sound and at Portland, San Francisco, Los Angeles, and other cities on the Pacific Coast. Most of the coke now consumed on the coast, according to the United States Geological Survey, is imported from Germany or England or is brought from the Eastern States.

OBITUARY

WILLIAM H. STORRS

William H. Storrs, manager of the Coal Creek Mining and Manufacturing Co., and the Poplar Creek Coal and Iron Co., died at Knoxville, Tenn., on December 2. Mr. Storrs was the eldest son of the late W. R. Storrs, General Coal Agent of the Delaware, Lackawanna & Western Railroad, in charge of the entire operations of its coal department. He was born at New London, Conn., December 1, 1854. He was prepared for college at Williston Seminary, East Hampton, Mass., and in 1873, entered Rennselaer Polytechnic Institute at Troy, N. Y. He left there in his junior year to commence work on his 21st birthday, at the opening of first (or "North") steel mill of the Lackawanna Iron and Coal Co., at Scranton, Pa.

In 1878 he went with the D., L. & W. Coal Department as General Outside Superintendent, later becoming Assistant General Coal Agent, and remaining in this position until 1899. During the last 5 years of this period, he was, owing to illness of his father, the General Coal Agent, in charge of the entire operations of the D., L. & W. Coal Department.

In 1899, he became manager of the Elk Hill Coal and Iron Co., the West Ridge Coal Co., and other coal interests of the Ontario & Western Railroad Co. Resigning from this position in 1903, he went to Knoxville, Tenn., as Manager of the Coal Creek Mining and Manufacturing Co., and the Poplar Creek Coal and Iron Co., owners, but not operators, of large tracts of bituminous coal in East Tennessee.

Mr. Storrs is survived by his widow, who was Miss Alice Matthews, of Scranton, Pa. A brother, Arthur Hovey Storrs, a well-known mining engineer, and a sister, Mrs. Chas. S. Weston, of Scranton, Pa.

Mining Institute Meetings

Proceedings of the Illinois, the Kentucky, the Scranton and the West Virginia Mining Institutes, and the Coal Mining Institute of America

Written for The Colliery Engineer

THE annual winter meeting of the Coal Mining Institute of America was opened with a business session December 4, 1913, in the Fort Pitt Hotel, Pittsburg, Pa., with President W. E. Fohl presiding.

After the secretary, C. L. Fay, had read his report, a discussion on the practicability of portable electric mine lamps, it was decided to name a committee to act with the State Department of Mines in an investigation of such a lamp, to cover safety and practical illumination purposes in mines.

In the afternoon, Harrington Emerson, consulting engineer of the Emerson Co., New York City, read a paper on "Efficiency of Bituminous Coal Mining," and made prominent mention of the fact that to operate mines at all times, even at occasional slight loss, was cheaper than to allow them to stand idle.

Clyde A. Brehm, electrical engineer of the Oliver-Snyder Steel Co., at Uniontown, Pa., read a paper on "Safeguarding the Use of Electricity in Mines," and urged the appointment of inspectors and licensed engineers as a means of reducing accidents.

The afternoon session came to a close with an address by Jesse K. Johnston, general superintendent of mines for the Pittsburg Plate Glass Co., at Creighton, Pa. Mr. Johnston spoke on "A Study of Wages, and the Selling Price of Coal in the Pittsburg District." He said that the cost of production, which was principally labor, the over-head costs, and the cost of selling in competitive markets, leave small margin for large investments.

In the evening at the banquet, the principal speakers were H. M. Wilson, of the United States Bureau of Mines, and Thomas L. Lewis, former president of the United Mine Workers of America.

Mr. Wilson took for his subject, "Industrial Safety," and said that the mining industry was the pioneer in the safety movement which had developed into such wide significance as the "Safety-First" campaign. He gave statistics of the number of men killed in the mines of this country, and said that the operators were slow in adopting a modern attitude toward handling coal-dust conditions. "Taking a chance" is not to be blamed entirely on the miner, but is said to be an American national failing.

Mr. Lewis, in the course of his remarks, advocated mine owners forgetting their individual interests, and working as a whole for the benefit of the industry. He said they could learn a lesson from the United Mine Workers, who had succeeded in increasing their wages 100 per cent. in 15 years. He urged a strong association among coal operators, and said there was no large industry that obtained so little recognition among the law-making bodies as coal mining. Among the objects of such an association would be to do away with some of the present statutes and substitute compensation laws in their stead. "The coal industry," he concluded, "is the most important and least respected in the country. It provides 60 per cent. of the freight traffic of the country and is the means of moving all other traffic. It is an industry upon which all others depend and without it, in my opinion, there would be no Pittsburg, the greatest industrial center in the country."

At the morning session of the second day, December 5, the following officers were elected for the ensuing year: President, Jesse R. Johnston, of Creighton, Pa.; first vice-president, William Seddon, of Brownsville, Pa.; second vice-president, A. P. Cameron, of Irwin, Pa.; third vice-president, I. G. Roby, of Uniontown, Pa.; secretary-treasurer, Charles L. Fay, of Wilkes-Barre, Pa. The executive board is: W. E. Fohl, of Pittsburg, Pa.; and Joseph Knapper, of Philipsburg, Pa. The following were appointed to confer with the officers of the State Bureau of Mines as to specifications for portable electric mine lamps: C. M. Means, consulting electrical engineer, Pittsburg, Pa.; R. N. Hosler, chief engineer of the Rochester and Pittsburg Coal and Iron Co., and J. Harris Booker, superintendent of the Pittsburg and Buffalo Coal Co., at Monongahela, Pa. C. L. Clark, of New Alexandria, Pa., and H. J. Meagher, of Elk Lick, Pa., were appointed as auditors.

After considerable discussion a committee was appointed, consisting of E. W. Parker, of Washington, D. C., Chairman; Geo. S. Rice, of Pittsburg, Pa.; and H. H. Stoek, of Urbana, Ill., to draft plans to promote cooperation among the institutes, so as not to have conflicting dates and to promote uniformity in getting out the proceedings. The idea is not to absorb any other institute, merely to work in conjunction with the rest.

G. A. Burrell, of the United States Bureau of Mines, read a paper on "The Relative Effect on Men and Small Animals of Small Amounts of Carbon Dioxide," and H. H. Clark, electrical engineer of the same bureau, delivered an address on "Portable Electric Mine Lamps."

J. R. Campbell, chief chemist, H. C. Frick Co., at Everson, Pa., read an interesting paper on "Basic Coke."

F. C. Keighley, general manager, Oliver-Snyder Steel Co., at Uniontown, spoke on "What is a Proper Method of Sampling the Beehive Coke Ovens for Analysis."

Pictures taken recently by Dr. W. R. Crane, Dean of the Mining Department, Pennsylvania State College, were shown, illustrating coal

mining fields and transportation problems encountered in Alaska.

From the doctor's remarks on weather conditions unfavorable to mining, it is problematic why one set of men should want these lands and another set of men who do not want them should antagonize those who do.

The meeting was probably the most successful so far held, at least that the writer has attended, for each paper, while valuable in itself, brought on discussions from which valuable information was obtained.

Kentucky Mining Institute

The mid-winter meeting of the Kentucky Mining Institute was held in Lexington, Ky., December 8, 1913, in the rooms of the College of Mines and Metallurgy, at the State University.

Judge Henry S. Barker, President of the State University, welcomed the members, and in a very interesting address told how, when he was judge the coal mine operators got the small end of the stick, and was sorry it was so customary. He did not consider it justice, but law seemed to be law when juries sat on cases in Kentucky, especially where the coal industry of the state was concerned. He felt that such laws held back the advancement of the state in this particular line of endeavor.

He complimented the work which Professor Norwood and his associates were doing in training young men along scientific lines which would develop the mineral wealth of the state, which at present was next to agriculture in importance and probably would shortly surpass agriculture in importance.

W. L. Moss, president of the Institute, responded to Judge Barker's kindly remarks, and thanked him for the encouragement he had offered to the Institute, when he said that "it was not good for man to live alone" and that encouragement and help would come from associations of men in the same line of endeavor meeting to exchange ideas in institutes of this kind.

Mr. R. D. Quickel, of Lexington, Ky., read a paper on the "Clinkering of Mixed Coals Under High Temperatures." This paper will be appreciated by coal men generally and is printed on another page, as it contains much valuable information obtained by experiments in burning coal in locomotives.

Mr. Newell G. Alford, of Earlington, read an instructive paper on "Problems Encountered in Mining Coals in the Western Coal Field of Kentucky." By making an abstract of this paper in this report, it would be difficult to do it justice, and it is probable that the entire paper will shortly be published in The Colliery Engineer.

W. C. Whitcomb, general manager of the George D. Whitcomb Co., Rochelle, Ill., prepared a paper on the "Use of Gasoline Motors in Coal Mines," which, in the absence of Mr. Whitcomb, was read by Professor Norwood.

The members regretted Mr. Whitcomb's absence because undoubtedly he could have made clear or explained some points which were not fully brought out in this excellent paper. "The Oil Fields of Northeastern Kentucky," by Dr. S. R. Collier, of West Liberty, was another paper presented. Prof. W. E. Freeman, of the University, read a paper on "Safeguards in the Use of Electricity in Mines." From the fact that this paper was not discussed, it may be taken for granted that it hit the spot. Mr. Otto A. Rothert, of Louisville, read a paper on "The Bearing of Coal Mining on Local History." Mr. Rothert wrote the history of Muhlenberg County, and this paper of his, while not technical, was very interesting and historical. It came in at a time in the proceedings where a paper free from technicalities could be appreciated, and it was.

The importance of the "Coming Session of the Legislature to the Mining Industry of the State," by Senator Joseph F. Bosworth, of Middlesboro, was a paper on the program, but unfortunately Senator Bosworth could not be present, and the Editor of The Colliery Engineer substituted by trying to explain the old and the new mechanical devices used in the surface arrangements at mines and underground.

In the evening the Mining Society of the College of Mines and Metallurgy tendered the guests a "smoker." The topics discussed were pertinent at this time and a good deal of hilarity was caused by the various operators telling their experiences and trying to compare notes on what constitutes a mine accident? When is death a fatal mine accident? What constitutes a serious mine accident? and What accidents should be reported for the Mine Inspector's records?

Refreshments were served during the evening, and all present when the "smoker" became a thing of the past, considered the meeting a success and the time devoted to it well spent. While the winter meeting is not so well attended as the summer meeting, there were more present than were expected, and the proceedings were carried on with a snap that made up for lack of attendance, so that those absent were the losers.

Illinois Mining Institute

The Illinois Mining Institute met in East St. Louis, November 22. The meeting was opened by the President of the Institute, John P. Reese, general manager of the coal properties of the Northwestern Railroad, who introduced Hon. John Chamberlain, Mayor of East St. Louis. Mayor Chamberlain described the advantages of East St. Louis as a railway and commercial center. President Reese replied in a felicitous manner and also announced that he would not be a candidate for re-election to the presidency of the Institute.

The minutes of the meeting held in June, also the minutes of a meeting of the Executive Board, were read and approved, after which a committee consisting of Mr. W. T. Morris, Mr. Thomas Little, and Mr. Thomas Back, audited the books of the treas-

urer. The new members enrolled brought the membership up to 75.

Mr. L. J. Szombathy was then introduced and explained the Szombathy safety lamp, which is of the Clanny type with four gauzes.

A paper by A. J. Moorshead, President of the Madison Coal Corporation was read by the Secretary, as Mr. Moorshead could not be present. It was on undercutting with special reference to the small sizes of coal made by the undercutting.

Thomas Moses, superintendent of the Bunsen Coal Co. next read a paper on "Accidents in Coal Mines Due to Coal Mining Machines." Mr. Moses' figures were based upon two mines, one using machines and the other hand mining, where the conditions were as nearly as possible alike. These figures showed that the accidents were more in the machine mine, and created a very animated discussion that resulted in a committee being appointed to conduct a systematic study of the subject and to report at the next meeting of the Institute. The committee consisted of Messrs. Moses, Dunlop, Bolt, Stock, and Ross.

Prof. H. H. Stoek, of the University of Illinois, presented a preliminary report upon the sizes of coal made in undercutting, based upon an examination of 10 mines, carried on by the Cooperative Mining Investigation of the State of Illinois.

The following officers were unanimously elected for the ensuing year: President, Thomas Moses; first vice-president, George Bagwell; second vice-president, H. Fishwick; secretary-treasurer, Martin Bolt; executive board members, H. H. Stoek, James Taylor, Alexander Watts, George Simpson, and John P. Reese. The report of the Secretary-Treasurer showed an unexpended balance of $137 and a membership of 75.

A paper was then read by W. L. Morgan, Mine Inspector of the 8th District, upon the subject of "Proper Methods of Inspecting a Mine." This paper was followed by a vigorous discussion upon the election of mine inspectors. It was the sense of the meeting that it would not be for the best interests of the mining industry to have inspectors elected. The next meeting will be held at Peoria in May, 1914.

West Virginia Mining Institute

The West Virginia Coal Mining Institute held its annual meeting in Charleston, December 8 and 9, 1913. President Neil Robinson opened the session with a paper entitled the "Mineral Man."

He was followed by Governor Hatfield, who is a physician, and who talked from his experience of 18 years in mining camps, on "Sanitation in and About Mines."

The next speaker was the Rev. T. C. Johnson, of Charleston, whose address was "Prohibition, as it Would Affect the Mining Region." He stated that even if the drastic law which goes into effect July 1, 1914, could not be or was not enforced to the letter, the measure would prove of greater benefit to the mining region than the open saloon, and as a result he predicted much better conditions all around.

President Robinson then read a telegram of felicitation that he asked permission to send to the Kentucky Mining Institute, also in session at Lexington, which was granted. This writing was greatly appreciated by the Kentucky Institute and President Moss telegraphed back the most distinguished considerations from that Institute.

Our old friend, Mr. Lee Ott, president of the Public Service Commission, spoke next on the workings of the Public Service Commission. He is one of the charter members of the Institute, and has but recently changed his avocation. He had 130 pages to his paper on "Workmen's Compensation," but he did not read them all. The subscribers to the fund numbered 1,465, which included all the coal companies. The employes under its operation number 143,706. The receipts for the two months since the law has been in operation amount to $186,025.99, and the disbursements to $1,026.39. The total premiums amounted to $194,269.66. He stated that the present indications were that a widow could be paid a lump sum of $2,150 on a basis of 3 per cent. interest compounded annually on balances, which is equivalent to $20 per month for 10 years, and showed how this $20 per month could be extended to 22 years. He also explained the method of classifying accidents by which the hazardous mines would have to bear their own burdens, and not require the non-hazardous to share them. In West Virginia, each company is taxed $1 per $100 on its pay roll monthly, and the companies are permitted to deduct 10 per cent. of this premium from their employes. The writer does not believe that the premiums will amass a fund sufficiently large to meet the accidents, as it is hoped.

In the evening ex-Governor McCorkle spoke on "What the Completion of the Panama Canal Means to West Virginia." Dr. W. R. Crane, Dean of the Mining School of State College of Pennsylvania, gave an illustrated lecture on "The Coal Resources of Alaska."

After adjournment, many of the members visited the Elks Lodge, where they were entertained in proper style by vaudeville, singing, and music. Doctor Cook, of Arctic exploration fame, lectured for about an hour on the habits of the Eskimo, and was well received. The doctor, who had lectured to people of Charleston earlier in the evening, is highly educated, and is certainly gaining the sympathy of the people whenever he comes in contact with them.

Tuesday morning, Mr. John S. Walker, Jr., of Huntington, read an interesting paper on "Continuous Coal Cutting Machines." The members of the Institute were agreeably surprised to have Mr. Callbreath, secretary of the American Mining Congress, appear to address them, and he certainly set forth the benefits to be obtained if the operators of West Virginia will pay more attention to state and national legis-

lation and demand their rights instead of fighting after adverse legislation. Again the Institute members were surprised when Carl Scholz, president of the American Mining Congress, was called on to address the meeting. His address was along lines which should convince the coal operators of the necessity of joining the American Mining Congress, and so take active steps toward combatting adverse legislation, by united effort; in other words, by adopting our national motto, "United we stand and divided we fall." In the past, coal mine operators have received some hard falls because they neglected to take affirmative action.

Mr. W. H. Grady, of Bluefield, who is connected with the Pocahontas Collieries Co., delivered an instructive address on "Pocahontas Mining Methods," which he illustrated by charts. We hope to be able to print this paper in The Colliery Engineer, in the near future.

Mr. John Laing, former chief of the Department of Mines, talked on "The Department of Mines," in the course of which he complimented the present incumbent, Mr. E. A. Henry. He also told how, by making confidants of the operators, he was successful in obtaining their cooperation, and thereby built up West Virginia coal mine inspection to a height where it compared favorably with other states.

The efficiency of the officers of the Institute was said to be such that they were all reelected for the year 1914. They are as follows: President, Neil Robinson, mining engineer, Charleston; vice-presidents, George T. Watson, vice-president Consolidation Coal Co., Fairmont; John Laing, coal operator, Charleston; R. S. Ord, general manager Elk Horn Coal and Coke Co., Maybeury; J. F. Healy, with United States Smelting and Refining Co., Salt Lake City, Utah; J. C. McKinley, coal operator, Wheeling; secretary-treasurer, E. N. Zern, Professor of Mining Engineering, Morgantown. Executive Board: President, vice-president, secretary-treasurer and Lee Ott, chairman Public Service Commission, Charleston; Clement Ross Jones, Dean of College of Engineering, West Virginia University, Morgantown; Daniel Howard, general manager Central Fairmont Coal Co., Clarkesburg; J. J. Lincoln, general manager Upland Coal Co., Elkhorn; J. B. Hanford (ex-officio) general superintendent Elkins Coal and Coke Co., Morgantown; Frank Haas (ex-officio) consulting engineer, Consolidation Coal Co., Fairmont. Here is an example of their efficiency: Mr. Frank Haas was to read a paper, but later it was ascertained that he and the paper got behind a freight wreck, and could not reach Charleston. The other Fairmont members evidently got behind the same wreck, and as this banquet, donated to the Institute by the City of Charleston, was the best ever, they are entitled to sympathy. The writer has to reluctantly cross off the name of Mr. George T. Watson, of Fairmont, from the list of speakers at the banquet.

As one of the Charleston papers stated, the educational program of the Institute closed at 4 P. M. This may be taken as a gross statement, for the city of Charleston is in training, and the tenets of the Institute were lived up to such an extent that Kanawha water was the only thing in evidence, although the unregenerate sang "How dry I am" at the start and ending of the eats. Toastmaster Gaines acknowledged that he was not accustomed to attend banquets of this kind, which showed he was determined to take the bull by the horns and go in training with the rest of the good people in Charleston. He then introduced President Robinson, who made a short address, eulogizing the New River Pioneers, Joseph L. Benny, John Cooper, and John Nuttall, who searched the hills until they brought to daylight the wonderful smokeless coal. Then came other giants, M. Erskine Miller, and A. Mason Miller, also Thomas G. McKell, John A. McGuffin, and a few others. Who can tell of their hardships, their struggles for markets, and their abiding faith in their product that governed every action? There were giants in the days of the early eighties.

Dr. I. C. White, the next speaker, said that 42 years ago he took up the study of geology under Mr. Stevenson. After graduation, he did his first practical work outside the state for the Second Geological Survey of Pennsylvania. After its completion he did some work for the United States Geological Survey, and as soon as West Virginia had a Survey his services were enlisted and he has been with the state since then. He then told of his work in West Virginia.

Doctor Sunny Jim Edward W. Parker, mathematician of the Statistical Department of the United States Geological Survey, talked next. He said some were endeavoring to prove that he was defending the coal trust, although he merely used the figures compiled by the Census Bureau in his speech at the American Mining Congress in Philadelphia. He was getting to be skittish about speaking in public, in fact believed he had talked too condemned much, when critics would not read plain English or did not know that he was quoting from a Department of the Government with which he had no connection. The rest of his address, the Charleston papers declared, was an excellent business talk.

Mr. Gaines said that Mr. Carl Scholz lived in Powellton, W. Va., not in Chicago, as the people generally supposed, and claimed also to be Mr. Scholz's English preceptor. He then introduced Mr. Scholz, who made a brilliant speech on the purposes and aims of the American Mining Congress. Col. Fred. Paul Grosscup was induced to talk on the Panama-Pacific Exposition. Mr. Grosscup is a Natural Gas man, when at work, and Mr. Barneveld can rest assured that Mr. Grosscup pleaded with the coal operators of West Virginia to make an exhibit of the state's greatest industry in a way that should attract their attention.

He showed what the advantages of a coal exhibition would be to the coal industry, and how it would help to open new markets and boom the state.

He is some speaker for an amateur, but it is believed that he was primed by Mr. Dickerson, who sat near him; however, Mr. Gaines was so very complimentary when introducing him it was a wonder he did not have stage fright. Judge Ira Robinson talked on the "Judiciary," and, switching from that subject, said that the men engaged in mining were doing more for the development of the great wealth of the state and the uplift of its people than all others. His speech was that of a polished student, as befitted one who has worn the ermine.

Hon. Fred Blue talked next on state administration, and made the statement that the taxes in West Virginia were lower than in any other state in the Union, as they are "only about 90 cents on the $100."

Mr. Fred. M. Staunton was then introduced and talked on the banking business and its relation to the coal man. He thought that West Virginia capitalists should erect and operate manufacturing enterprises that would make use of the state's own products and not ship them all away.

Dr. J. E. Beebe, of Chicago, the next speaker, in a noisy voice, berated all the other speakers for furnishing the coal mining institute with hot air. He said not one word had been said during the evening about the Coal Mining Institute of West Virginia, of which he had been a member for 5 years, and he resented it because it was the best of all the mining institutes. This took the speakers up in the air, so that having arrived at their destination, Br'er Beebe let them down gently and felicitously, thus ending one of the most enjoyable banquets ever held anywhere.

Mr. Austin, of Pittsburg, led the singing of those colored melodies which never grow old.

Scranton Mining Institute

The fourth annual banquet of the Scranton Mining Institute was held in the Town Hall, Scranton, Pa., on Saturday evening, November 29, 1913, with an attendance of nearly 1,500 men.

Andrew Bryden, president of the Institute, in a brief address, welcomed the guests and introduced C. E. Tobey, assistant general superintendent of the D., L. & W. R. R. Coal Department, as the toastmaster, who, after a brief introductory speech, introduced as the speaker of the evening, Dr. J. A. Holmes, Director of the United States Bureau of Mines.

Doctor Holmes launched into his subject, going directly to that part of it nearest his heart, namely, the limitations under which the department of which he is the head, is compelled to work. He maintained that the great mining industry should, at least, be on a par with the agricultural industry, and instead of being one department of a bureau, should be a bureau in itself with an officer in the cabinet and the power to do something. At present, he explained, his department has absolutely no power except to make experiments.

Conservation of the natural resources was also touched upon, the speaker declaring that in mining we should remember that we have but one great supply, and that when that is gone, we shall be left without any. Touching upon safety, Doctor Holmes declared that in this country we do not have the cooperation we should have between miners, operators, and inspectors; we have no concerted action. Declaring that the loss of life by mining in the United States was greater than in any other country, Doctor Holmes said that he did not think that our miners were more careless than they were in other countries, nor did he believe that the operators in the United States were more heartless than they were in other countries, but that what was needed was more supervision. The United States, the state, the operator, and the miner must get closer together and pull together, and in time they will succeed in making the mines of the United States the safest of any country in the world.

Congressman John R. Farr, when introduced, called the attention of the men present to the subject of compensation laws which have been agitated recently and declaring that he was in favor of them, advised his hearers to do as the railroad men had done and think out for themselves a plan of compensation which would provide for them in case of injury, or provide for their families in case of death. Calling attention to the pending compensation act, which he prophesied would be passed by the present Congress and which applies to all interstate railroads, Mr. Farr declared that all issues and all legislation must begin with the people, and that if the mine workers wanted to benefit by a compensation act, they would have to work out a plan for themselves, and then put it squarely up to the state. "In this organization of yours," declared Mr. Farr, "you can work it out, you can think it out, and it is worth your while working along that line. You can solve a good many problems in this organization before they go to the legislature."

Hon. C. F. Swift, one of the preacher members of the legislature, who comes from Beaver County, took for his subject, "Efficiency," and after saying that every man was either his own greatest enemy or his greatest friend, proceeded to analyze the statement. God never put a limitation on human life, he said, and if there were any limitations on any one's life, that person alone put them there. Man's greatest asset is his health and efficiency, and when he does anything that injures his health, he at the same time, injures his efficiency. Declaring that the greatest enemy this country has is alcohol, Mr. Swift showed that the minute a man took alcohol into his system, he damaged his health and therefore his efficiency.

Some Notes on Mines and Mining

Captain J. M. Elliott, who for 6 months has been investigating deposits of coal in Blount Mountain, 25 miles west of Gadsden, Ala., reported that three seams, with a total of 11 feet, have been uncovered at entrances, and that extensive drilling will be undertaken at once to prove that the deductions are correct. The top seam is 3 feet thick.

NOVA SCOTIA

The Nova Scotia Mining Society, which for many years has had its headquarters in Halifax, has recently removed to Sydney, Cape Breton. The change is significant of the decay of the gold-mining industry and the rise of the coal industry in Nova Scotia. The production of coal now overshadows all the other mineral industries of Nova Scotia, and, as the greater part of the coal output comes from Cape Breton Island, it is but natural that Sydney should now be considered the best location for the headquarters of this long-established mining society. The first meeting in the new quarters will probably be held early in 1914.

The output of the Dominion Coal Co.'s collieries will probably reach 5,100,000 tons for the year 1913, or about 230,000 tons in advance of 1912. The largest output of the year was obtained in October, namely 438,000 tons from the Cape Breton collieries, and 32,000 tons from the Springhill mines, or 470,000 tons in all. This month's output was also the greatest yet produced by the Dominion Company's collieries. This company has now nineteen collieries in full operation and one colliery, recently unwatered, ready to produce coal.

Since 1904 the Dominion Coal Co. has had an agreement covering wages and conditions of employment with the Provincial Workmen's Association, representing the mine employes. This agreement has been renewed at intervals of two or three years since it was first entered into in 1904, and expires at the end of 1913. A new agreement has been come to which continues the terms of the original agreement for a further period of 3 years, or to the end of 1916. A 6 per cent. increase in wages has been granted to all day-paid men earning under $2 per day, and consideration is also to be given to men earning over $2. Under the increased schedule the minimum rate of ordinary mine labor will be raised from $1.60 per day to $1.70, and the rate of the mine shiftman will be increased from $1.75 to $1.85. During the 12-year period covered by this wage agreement from 1904 to the end of 1916, the minimum rate of ordinary mine labor has risen from $1.38 to $1.70, and the minimum rate of the shiftman has increased from $1.65 to $1.85. The renewal of this agreement practically ensures freedom from labor troubles in the mining industry of Nova Scotia for at least 3 years to come, as the Dominion Coal Co. controls and produces 75 per cent. of the coal output of the province.

The Cape Breton Coal, Iron and Railway Co., is now producing coal from its Broughton colliery, which is situated on the fringe of the Glace Bay coal field. Arrangements have been made to ship the coal of this company over the railway and piers of the Dominion Coal Co. The Cape Breton Co. has been promoted by English capital, and a large capital expenditure has been made on the property. The output will not be very large until the summer of 1914.

PENNSYLVANIA

The Pennsylvania R.R. Co. is pushing the construction of a stem of its Tyrone and Clearfield branch up Victor Hollow, a short distance from Philipsburg, Pa., about 1½ miles, where 1,500 acres of Moshannon-seam coal is to be developed on property owned by R. H. Mull, Harry Phillips, and the Ayers Estate, also reaching property of the Philipsburg Coal and Land Co.

The boiler house and some of the other buildings at the Clare Coke Co.'s plant near Welty, Westmoreland County, Pa., were burned last month.

The tipple engine house and boiler house at the Springfield Coal Mining Co.'s mine at Nanty Glo, Cambria County, Pa., were burned recently, necessitating a shut-down which will probably last for several weeks. The mine employs about 200 men. Rembrandt Peale and several other well-known operators are interested in the company.

The Sunnyside Coal Co., has begun the installation of electrical equipment in its mine at Johnstown, Pa., and has also started work in the E seam, at the same time continuing the development of the C seam. As a result of the improvements and developments now under way, the company's present output of 500 or 600 tons a day will be materially increased in the next few months.

W. M. Wallace, treasurer of the Pittsburgh Coal Co., has purchased at public auction the Illinois Collieries Co., owning 8 mines and having a bonded indebtedness of $3,000,000. It is understood that the Pittsburgh Coal Co. has had an interest in this enterprise for years past, dating back to the time of the Robbins administration.

Willett G. Miller, LL.D., Provincial Geologist of Ontario, Canada, was tendered a complimentary banquet at the Toronto Club, November 1. Doctor Miller could have made use of his great knowledge of the Cobalt District to have become a rich man, but like most educated men, refused to consider self-interests while in the service of the Government, therefore, in recognition of his sterling character, indefatigable industry, and for his aid in establishing and developing the mining industry, he has been honored by the mining men of Canada, and presented with an oil painting of himself. Personally, Doctor Miller is a man who shrinks from publicity, but whose magnetism, kindliness and intellectuality draw men to him, and those who have once met him hold him in respect.

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

50. How would you find the distance between two shafts which are divided by a river? No other instrument than a tape is available.

51. An endless rope has to be driven by an electric motor. The rope wheel has to make seven revolutions per minute and the motor makes 1,000 revolutions per minute. Show by sketches how you would arrange the intermediate gearing, giving diameters of gear-wheels.

52. Explain the principal points requiring your attention in laying out 3 miles of colliery railway over undulating land. What is the minimum radius of curve that you would adopt, assuming that large locomotives of standard gauge had to work thereon?

53. Make a sketch of a fan drift in which provision is made for reversing the ventilation without having to reverse the fan.

Answers for Which Prizes Have Been Awarded

Ques. 35.—What would be the resultant gases in the air of a mine after (1) an explosion of gas and coal dust, (2) the detonation of dynamite, and (3) an underground fire? What is the nature of the gases in each case, their effect on life, and the method of dealing with them?

Ans.—(1) The chemical changes taking place in the mine are as follows:

The oxygen of the air unites with the carbon of CH_4 to produce CO_2 where a plentiful supply of air is present; a portion of the oxygen also combines with the H of the CH_4 to produce water vapor H_2O; where the supply of air is limited the combustion of the carbon is not complete and a varying amount of CO is produced, the N of the air remaining unchanged in both cases; if the coal or gob contains sulphur, H_2S will be generated also. The coal dust rendered incandescent by the flame of the explosion acts on the carbon dioxide to produce a larger proportion of CO than would otherwise result, thus rendering the afterdamp again explosive. This mixture or afterdamp is sometimes explosive, poisonous, or suffocating, and more lives are lost by it than by the force of the explosion itself.

(2) Dynamite consists of nitroglycerine absorbed generally in wood pulp to which sodium nitrate is added. The gases produced in an explosion of one volume of dynamite may be stated as follows: Carbon dioxide, 469 volumes; moisture, 554 volumes; free nitrogen, 158 volumes; making 1,259 volumes. The volumes of gases produced and the gases themselves vary considerably according to the conditions under which the explosion takes place.

(3) The O of the air is consumed by the burning of the coal leaving large amounts of N. If much air is present CO_2 is produced; if there is sulphur with the coal, SO_2 and SO_3, these are very noxious gases; a smoldering fire with limited amount of air generates CO, which is explosive and very poisonous, it also generates small proportions of CH_4 and H_2S.

Gases from explosions of gas, coal dust, and mine fires, are explosive, poisonous, or cause death by suffocation, and should be approached from the intake side only and then with due precaution, the exploring party having helmets, safety lamps, electrical and naphtha, also a canary bird, this work to be done by experienced men. First explore the mine, put out all fires and remove the gases slowly, using nothing but safety lamps; guard the outside that no open lights come in contact with the return air.

Gases from dynamite are very injurious to health and should be removed by a plentiful supply of air; a workman should not go to the working face for at least 5 or 10 minutes after the shot is fired or until the smoke and gases are cleared away.

Fred Vinton

Heilwood, Pa.

Ques. 43.—A fan driven by an electric motor produces 150,000 cubic feet of air per minute, 4 inches water

gauge. The efficiency of the motor is 90 per cent. On the switchboard the voltage is 600 volts, and the ammeter reads 185 amperes. What is the efficiency of the fan?

Ans.—(*a*) Quantity of air = 150,000 cubic feet per minute.

Water gauge = 4 inches.

Pressure = 4×5.2 pounds = 20.8 pounds per square feet.

$$\frac{Q \times P}{33{,}000 \text{ lb.}} = \text{H. P.} = \frac{150{,}000 \times 20.8}{33{,}000} = \frac{3{,}120{,}000}{33{,}000} \text{ foot-pounds} = 94.55 \text{ H. P.}$$

= power expended on air-current.

(*b*) Volts = 600.

Amperes = 185.

Volts × amperes = watts = 600×185 = 111.000 watts. 746 watts = 1 horsepower.

111,000 watts ÷ 746 = 148.78 H. P. = power expended on motor pulley. Motor is 90 per cent. efficient; 90 per cent. of 148.78 H. P. = 133.90 H. P. = power actually expended on motor pulley.

(*c*) 133.90 H. P. − 94.55 H. P. = 39.35 H. P. = power lost due to inefficiency of fan.

(*d*) 94.55 H. P. ÷ 133.90 H. P. = 70.6 per cent. actual efficiency of fan. W. E. Richards

Lilly, Pa.

Second Prize, James Dickson, Manaimo, B. C.

Ques. 44.—What is the essential difference in composition between bituminous, semibituminous, and anthracite coals? Assume that the former and latter are being burnt in open, separate grates, and state the difference you can detect by burning.

Ans.—The essential difference in composition of bituminous, semibituminous and anthracite coal is shown by the following analyses:

	Fixed Carbon	Volatile Matter	Heating Value Per Pound Combustible or B. T. U. Per Pound	Relative Value of Combustibles
Bituminous	75 to 60	25 to 40	14,800 to 15,500	96
Semibituminous	87.5 to 75	12.5 to 25	15,500 to 16,000	100
Anthracite	97 to 92.5	3 to 7.5	14,600 to 14,800	93

Coal is composed of four different things, which may be separated by proximate analysis, viz.: fixed carbon, volatile hydrocarbon, ash, and moisture.

The fixed carbon has a constant heating value of about 14,600 British thermal units per pound. The value of the volatile hydrocarbon depends on its composition, and that depends chiefly on the district in which the coal is mined. It may be as high as 21,000 British thermal units per pound, or about the heating value of marsh gas, in the best semibituminous coals, which contain very small percentages of oxygen; or as low as 12,000 British thermal units per pound, as in those from some of the Western States, which are high in oxygen. The ash has no heating value, and the moisture has in effect less than none, for its evaporation and the superheating of the chimney gases absorb some of the heat generated by the combustion of the fixed carbon and volatile matter. The relation of the volatile matter and of fixed carbon in the combustible portion of the coal, enables us to judge the class to which the coal belongs, as coals containing less than 7.5 per cent. volatile matter in the combustible would be classed as anthracite; between 12.5 and 25 per cent., as semibituminous; between 25 and 50 per cent., as bituminous.

The heating value of a coal depends upon its percentage of total combustible matter, and on the heating value per pound of that combustible. The latter differs in different districts and bears a relation to the percentage of volatile matter. It is highest in semibituminous coals, being nearly constant at about 15,750 British thermal units per pound. It is between 14,500 and 15,000 British thermal units in anthracite, and ranges from 15,000 down to 13,000 in the bituminous coals, decreasing as the western districts are approached.

The analyses given in the table show the comparison of fixed, volatile matter, etc., and also show the relative value of combustibles of anthracite, bituminous, and semibituminous, basing semibituminous as 100 per cent.

The first observation in the burning of anthracite on an open grate is the difficulty in kindling or igniting the coal. Once burning, it burns with little flame and no smoke, but gives great heat.

In the burning of bituminous coal on a similar grate, it is readily seen that bituminous coal ignites more quickly and burns with a yellow smoky flame; the heating value as given in the table shows bituminous to have a slightly higher heating value per pound.

I might note for the reader's benefit, that on burning semibituminous coal on an open grate, this coal seemed to kindle more quickly than either of the above, and burned quickly with a steady fire, hence its value as a steam coal.

The anthracite bed lasted the longest. F. H. Wagner

Second Prize, C. H. Beidenmiller, Nanticoke, Pa.

Ques. 45.—A seam of coal dipping 12 degrees is thrown down 200 feet by a vertical fault. A slope is started from the top of the downthrow and cuts the seam 400 feet horizontally from the fault. Required the length and dip of slope.

Ans.—The vertical fault has thrown the seam down 200 feet. In addition to this downthrow caused by the fault, there is another drop to the point where the slope cuts the seam, represented by the side BC in the triangle BCD, shown in Fig. 1; this is due to the dip of the seam.

To find this additional drop, solve the triangle BCD, in which is given, by the conditions of the problem, the length of the horizontal line CD, 400 feet, and the angle BDC, 12 degrees. The tangent of the angle BDC is the function of the angle which deals with the two sides, the given and the required one, the tangent of the angle BDC being $\frac{BC}{CD}$.

Now, if $\tan B\,D\,C = \frac{B\,C}{C\,D}$;

then, $B\,C = C\,D \times \tan B\,D\,C$.

Substituting,

$B\,C = 400 \times .21256 = 85.024$ feet

The total difference in elevation, then, between the point where the slope is to start and the point where it is to cut the seam, is 200 feet +85.024 feet, or 285.024 feet.

In the triangle $A\,C\,D$, in which the side $A\,D$ represents the length of

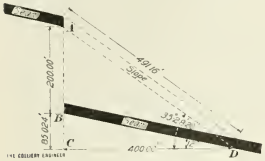


Fig. 1

the slope, and the angle $A\,D\,C$ the degree of dip of the slope, the side $A\,C = 285.024$ feet, and the side $C\,D = 400$ feet. These two sides are the sides of the triangle, the relation between which is the tangent of the angle $A\,D\,C$, for

$$\tan A\,D\,C = \frac{A\,C}{C\,D}$$

Substituting,

$$\tan A\,D\,C = \frac{285.024}{400} = .71256$$

The angle whose tangent is .71256, is found from tables to be 35° 28′. Therefore, the degree of dip of the slope is 35° 28′.

To find the length of the slope, there are three methods we may employ. We have a right triangle, in which are given the two legs, to find the hypothenuse. This may be found by extracting the square root of the sum of the squares of the two sides; or it may be found by dividing either the side $A\,C$ by the sine of the degree of pitch, or the side $C\,D$ by the cosine of the degree of pitch, for

(1) $\sin A\,D\,C = \frac{A\,C}{A\,D}$ and

$$A\,D = \frac{A\,C}{\sin A\,D\,C}$$

and

(2) $\cos A\,D\,C = \frac{C\,D}{A\,D}$

and $A\,D = \frac{C\,D}{\cos A\,D\,C}$

Substituting in the first of these formulas the values of the side $A\,C$ and the sine of the angle $A\,D\,C$,

$$A\,D = \frac{285.024}{.58031} = 491.16 + \text{feet}$$

Squaring the two sides of the triangle, taking the sums of the squares, and extracting the square root,

$(285.024)^2 = 81{,}238.68$

$(400)^2 = 160{,}000.00$

$241{,}238.68$

Taking the square root we have: $\sqrt{241{,}238.68} = 491.16$, which checks our previous result. The length of the slope is, therefore, 491.16 feet.

E. C. Lee

West Pittston, Pa.

Second Prize, C. H. Beidenmiller, Nanticoke, Pa.

BOOK REVIEW

A review of the latest books on Mining and related subjects

O'Harra's Handbook of The Black Hills. This book is written by President C. C. O'Harra, of the South Dakota School of Mines. It contains 6 maps, 160 pages and is illustrated. It is intended to convey authentic information about the Black Hills, and will be valuable as a book of reference for those who wish to know the geology, agricultural, and other natural advantages of this interesting part of our country.

The book may be obtained from Black Hills Handbook Co., Rapid City, S. Dak. Price 75 cents.

Gold, Prices and Wages. This book is by J. A. Hobson. It contains 181 pages and is published by Methuen & Co., Ltd., London, England, and George H. Doran Co., New York, N. Y. The author says:

"The current rise of prices is an exceedingly attractive problem for two reasons: First, its intellectual toughness and intricacy: Second, for whatever other causes contribute to the social unrest from which most nations are suffering it seems certain that the rise of prices has acted everywhere as a main source of irritation." Mr. Hobson is an economic writer of note, whose propositions, if open to argument, are along lines of present conditions rather than the past. The natural laws of economics having been obfuscated by artificial man-made economics, thinkers on those subjects will be greatly interested in the author's deductions. Price $1.25.

West Virginia Geological Survey. There has just been issued by the West Virginia Geological Survey, Morgantown, W. Va., a detailed Report on Cabell, Wayne and Lincoln Counties, 483 pages plus XVI, with 26 half-tone plates and 6 zinc etchings in the text, also a case of 9 maps, covering the soils, topography, and geology of each county separately. In addition to the description of all geologic features of the counties in question, the maps give the structural contours on the Pittsburg coal horizon, also the location of the anticlines and synclines, showing their relations to the several oil and gas pools of the district. The soil maps and reports of the United States Department of Agriculture cover this great agricultural and tobacco region of the state and are of especial value to the agricultural and horticultural interests. Price, with case of maps, delivery charges paid by the Survey, $2. Extra topographic or geologic maps, 25 cents for each county.

Cyanidation in Mercur. A detailed and complete account of the progress of cyanidation in the Mercur district of Utah, where the process made its earliest successes. By L. O. Howard, with introductory chapter by Don Maguire. This pamphlet, while historical, has technical matter distributed through the text in a way which does not detract from the story.

Contents: The Romance of a Famous Gold Mine, Treatment of Mercur Dumps, Milling at the Geyser Marion, Cyaniding at the Sunshine Mine, Cyaniding at the Overland Mill, Modern Filtration's Debt to Sunshine, Cyaniding on the West Dip, General Notes on Mercur Practice. The pamphlet contains 72 pages, 41 illustrations, 7 in. × 10 in. Price 50 cents, postpaid. For sale by The Salt Lake Mining Review.

The University of Kansas Science Bulletin contains the following papers: The Pennsylvania Amphibia of the Mazon Creek, Illinois, Shales, by Roy L. Moodie; Krameria Canescens Gray, by Charles M. Sterling; Evidence of Pleistocene Crustal Movements in the Mississippi Valley, by J E. Todd; A Comparison of Three Skulls, by H. T. Martin; Cytological Studies, by Nadine Nowlin; The Science Bulletin replaces the Kansas University Quarterly and Geological Survey and is a high-class bulletin with excellent illustrations. Address, Lawrence, Kans.

Mine Surveying. Edward B. Durham, E. M., Associate Professor of Mining, University of California. 375 pages, illustrated, $3.50 net. This book, recent from the press of the McGraw-Hill Book Co., meets the requirements of a book that has long been wanted by coal and metal mining engineers. Professor Durham has taken up in great detail the general methods of surveying, equipment for underground surveying, maps, special problems in mine surveying, steep transit sights, shaft plumbing, tunnel surveys, exploratory and magnetic surveys. The book is bound in flexible leather and is pleasing to the eye in appearance as well as contents. No engineer or transitman should be without this valuable treatise.

We have received the second number of *The Employes' Magazine*, the quarterly issued by the Lehigh Valley Coal Co., for free distribution among its employes, to promote greater safety, efficiency, economy, and cooperation throughout its organization. The number just issued is a useful, interesting, and handsomely illustrated one, and is in fact, superior to the first number, which was a commendable one.

More than 3,000 small logging operators now buy national forest timber; at least 25,000 persons, settlers, miners, and others, obtain timber from Uncle Sam's big wood lot for their own use free of charge.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not neccessarily for publication.

The editors are not responsible for views expressed by correspondents.

Effect on Roof of Dewatering a Flooded Mine

Editor The Colliery Engineer:

Sir:—I have a mine that has been flooded. Previous to the flooding there was practically 600 acres worked over. The vertical hoisting shaft is located near the center of the worked area. The coal seam is from 5 feet to 6 feet thick and dips slightly in an easterly direction. The levels show that the extreme western workings are 56 feet higher than the bottom of the seam at the shaft, and the extreme eastern workings are 19.74 feet lower than the same point.

It has been decided to dewater the mine by pumping and hoisting; the pumping and hoisting station to be located at the main shaft. Several parties have expressed opinions that in removing the water, a vacuum will be created in the workings near the western extremity of the mine, which will likely cause damage to the mine, either by falls, a squeeze, or a rushing of air or water. I will be obliged to the practical readers of The Colliery Engineer, who may have had experience in similar cases for their opinions as to the liability of such things occurring.

G. I. E.

Terre Haute, Ind.

"The Wisest Man"

Editor The Colliery Engineer:

Sir:—Maybe it was Solomon who said "there is nothing new under the sun," be that as it may, the idea of pumping fine coal to market which is being advocated as something new, is quite aged. Mr. Allan Stirling, of boiler fame, proposed some years ago to pump culm from the anthracite field to stations where boiler plants were to be established and electric power generated. There was only one drawback to this plan, the owners of the culm piles would not go along, so no dependable quantity of coal was available. Coal is being pumped across the Susquehanna at Plymouth, Pa., and the Philadelphia & Reading Coal and Iron Co., has, for some years, been pumping sludge with plunger pumps to the top of a mountain where it could flow by gravity into the next valley. It is presumed that Solomon was not in the coal business; he was too wise for anything but the transportation or pipe line end of it.

Scranton, Pa. Coal Miner

Pumping Coal to Market

Editor The Colliery Engineer:

Sir:—Your contemporaries are describing as novel, the idea of pumping a mixture of coal and water to market; the plan being attributed to both American and English engineers.

The suggestion is by no means new, at least in this country. The idea originated some 10 or 12 years ago with a Mr. Andrews, who, I believe, is or was of the Youngstown and Cleveland family of that name, and was then president of a coal company with mines in the Pittsburg, Pa., district. The price of slack was very low—at or under 25 cents a ton at the mines—and Mr. Andrews built a small experimental plant, in order to demonstrate the possibility of pumping a mixture of slack and water to New York City. At destination, the mixture was to be

received in large settling basins on the New Jersey side of the river, and the slack, after being drained of the surplus moisture, was to be used under boilers or converted into coal gas and this sold to the gas companies in New York. Mr. Andrews went to considerable expense in the matter and his engineers had satisfied him that a mixture of 50 per cent. slack and 50 per cent. water could readily be pumped from Pittsburg to Jersey City, and at a cost very much less than the all-rail rate then prevailing. Just why the idea was abandoned, I do not recall; possibly because of legal difficulties in the way of securing the necessary rights of way, as the law of eminent domain would, naturally, not apply.

Chicago, Ill.

Francis G. Wells

An Emergency Hospital

Editor The Colliery Engineer:

Sir:—When a man is injured in the mines, few men realize that if he is treated and made as comfortable as possible before starting on his rough ride to the surface, half the battle is fought.

At the Naomi mine of the Naomi Coal Co., near Belle Vernon, Pa., an emergency hospital has been constructed within 5 minutes ride on an electric locomotive from any working place. The hospital walls are of concrete and it is divided into two rooms with a connecting doorway. Each room is equipped with a steel locker, and a mine telephone is set in the wall of the outer room. The entire hospital is heated and lighted by electricity. In the back room, which is used exclusively for the treatment of injured persons, are hot and cold water, all medicines, soaps, disinfectants, towels, first-aid cabinet, woolen and rubber blankets, stretchers, splints, etc. This room is kept warm and well ventilated all the time and has a concrete slab on which to lay the patient, a concrete table is nearby, and a graniteware sink with running water. The outer room is used as an anteroom.

It is a rare sight to see anything like this so close to the working faces, and probably it is the only one in the Monongahela Valley. The hospital was built and equipped under the personal supervision of the mine foreman, J. E. Cheynoweth. The slogan at the mine is "For Humanity's Sake."

A Visitor

Mine Safety Association

Editor The Colliery Engineer:

Sir:—Please print the enclosed and oblige.

OPEN LETTER TO MINERS AND OPERATORS

To the Coal Operators and Miners Unions of the United States:

Gentlemen:—As President of American Mine Safety Association, I consider it my duty (as well as a pleasure), to call your attention to, and invite you to join and support this "Joint Movement" for safer mining in the United States. This organization is one that should receive the moral and financial support of every miner and operator in the country, regardless of any and all other considerations. Associate membership can be secured by any coal company or any organization, local union, or group of mine workers, at a cost of $10 per year. Can you afford to fail or refuse to take out such membership? "Do it now" by making application to Mr. H. M. Wilson, 40th and Butler Streets, Pittsburg, Pa., who is secretary-treasurer.

Hoping this appeal will not be in vain, I beg to remain, yours for safer mining,

John P. Reese,
President, American Mine Safety Association

Gillespie, Ill.

Explanation of Formulas

Editor The Colliery Engineer:

Sir:—Kindly show how the formula $W=\frac{1.3253\times B}{459+t}$ is derived. Also, what is meant by moment of inertia of cross-section of a beam?

Old Reader

Careful experiments show that 459 cubic feet of air at 0°F. weigh 39.76 pounds, when the pressure is 30 inches of mercury of a density due to 30°F. This pressure is equal to about 14.7 pounds per square inch, but when the pressure is 1 inch of mercury, the 459 cubic feet of air would weigh but $\frac{39.76}{30}=1.3253$. If the barometer stood at 2 inches of mercury high, the 459 cubic feet of air would weigh 2.6506 pounds, etc. In the formula, B = height of the barometer in inches of mercury; t = temperature by Fahrenheit's barometer; W = weight of a cubic foot of air, at any height of the barometer and temperature.

Hence, $W=\frac{1.3253\times B}{459+t}$

The moment of inertia of a cross-section of any shape is an expression used in determining the resistance of a beam to bending when subjected to a load. The moment of inertia varies according to the shape of the beam, but as a usual thing the expression corresponding to the shape can be obtained from pocketbooks or from textbooks that treat on the strength of materials.

Editor

Real Heroism

In these days of cheap hero worship it is inevitable that real heroism should be overlooked by the readers of a sensational press. We desire to record an incident of the Senghenydd disaster. A few hours after the explosion in this Welsh coal mine, it was known that all those who went underground to rescue or search for the 400 entombed miners would do so at the risk of their lives. However, the committee of seven men who had the rescue work in hand decided to lead a forlorn hope. So desperate were their chances, says *The Times*, that these seven men went to separate parts of the room and wrote farewell letters. Three made their wills. Then they went to work. They succeeded in bringing 18 men to the surface. That is worth more than bushels of Arctic histrionics.—*The Mining Magazine.*

Answers to Examination Questions

Questions Selected from Those Asked First-Class Candidates in British Columbia, May 27, 1913*

Ques. 1.—If the specific gravity of marsh gas at a temperature of 60° F., barometer 30 inches, is .559, what will 100 cubic feet weigh?

Ans.—The weight of 1 cubic foot of dry air under the conditions named is found from the formula $W = \frac{1.3273 \times B}{460+T} = \frac{1.3273 \times 30}{460+60} = .07657$ pound. In the above formula, B = height of the barometer column in inches, and T = the temperature. One hundred cubic feet of air will weigh $100 \times .07657 = 7.657$ pounds. Since marsh gas weighs .559 as much as air, the weight of 100 cubic feet of this gas will be $7.657 \times .559 = 4.28$ pounds.

Ques. 2.—In a mine giving off 2,500 cubic feet of marsh gas per minute, the volume of air entering the intake opening is 4,500,000 cubic feet per hour; what is the percentage of gas in the return current? Would you consider this percentage of gas dangerous?

Ans.—The volume of fresh air entering the mine each minute is $4,500,000 \div 60 = 75,000$ cubic feet. To this is added 2,500 cubic feet of marsh gas, making the total volume of mixed gas and air in the return $75,000 + 2,500 = 77,500$ cubic feet. In this mixture the proportion of marsh gas is $2,500 \div 77,500 = .0323 = 3.23$ per cent.

This percentage of marsh gas does not produce an explosive mixture, but is extremely dangerous, particularly in bituminous coal mines. In the presence of coal dust, this proportion of marsh gas would be very apt to cause a "dust explosion," through the agency of a blown-out shot, etc.

Ques. 3.—What are the important factors necessary to ensure good ventilation at the face of the mine, and not get too high a water guage, provided the quantity entering the mine is fully adequate?

Ans.—The question assumes that the fan is large enough to supply all the air needed, so that the possible troubles are between it and the face. Leakage and friction are the chief things working against getting the full amount of the intake air to the face. Loss of air by leakage may be overcome by making air-tight the brattices, doors, overcasts, and other structures used in directing the ventilating current. Friction may be reduced by making the airways as large as is economically possible, and then keeping them clean and free from falls, etc. Friction may also be reduced by dividing the air-current into a number of separate splits instead of carrying it through the workings in a single unbroken current.

Ques. 4.—If the velocity of the air-current is 4 feet per second, and it is required to increase it to 8 feet per second, what will be the ratio of increase in power?

Ans.—For this purpose we may use the formula, $u = k\,s\,v^3$, in which u is the power on the air, k = coefficient of friction, s = area of the rubbing surface, and v = the velocity. Since k and s are the same in each case, they may be dropped and we have $u = v^3$, which is equivalent to stating that the power varies as the cube of the velocity. Substituting for v the first velocity, 4, we have $q = 4^3 = 64$; and substituting the second velocity, 8, we have $q = 8^3 = 512$. Hence, the powers are in the ratio of 64 to 512, or as 1 to 8. This conclusion may be arrived at more simply by using the statement given above to the effect that the power varies as the cube of the velocity. Since the velocity is doubled ($8 \div 4 = 2$), the power is increased in the ratio of 1^3 to 2^3, or as 1 to 8.

Ques. 5.—A square field of 32,400 square yards in area overlies a seam of coal 4 feet thick, pitching at an angle of 1 foot vertical in 6 feet horizontal; what is the total weight of coal, in the field, its specific gravity being 1.28?

Ans.—Assuming that the coal is flat, and because there are 9 square feet in 1 square yard, there are $32,400 \times 9 \times 4 = 1,166,400$ cubic feet of coal under the tract. Since a cubic foot of water weighs $62\frac{1}{2}$ pounds, and the specific gravity of the coal is 1.28, there are in the field $(1,166,400 \times 62\frac{1}{2} \times 1.28) \div 2,000 = 93,063,168 \div 2,000 = 46,532$ tons.

Since the seam is pitching 1 in 6, the tangent of the angle of inclination $= 1 \div 6 = .16667$, and the angle of inclination is 9° 28′ very nearly. From this, the amount of coal in this pitching seam is $46,532 \div \cos$ angle of pitch $= 46,532 \div .98638 = 47,175$ short tons.

Ques. 6.—In what time can an engine of 40 effective horsepower pump 4,000 cubic feet of water from a depth of 360 feet?

Ans.— 4,000 cubic feet of water weighs $4,000 \times 62\frac{1}{2} = 249,333\frac{1}{3}$ pounds. The work necessary to raise this water is $249,333\frac{1}{3} \times 360 = 89,760,000$ foot-pounds. Forty horsepower is equal to $40 \times 33,000 = 1,320,000$ pounds raised 1 foot high in 1 min-

*Note.—The questions are selected at random and the numbers used here are not those used in the examination.

ute, or to that number of foot-pounds. Hence to raise the water or to exert 89,760,000 foot-pounds, will require $89,760,000 \div 1,320,000 =$ 68 minutes. This makes no allowance for slip of the pump, unless the use of the word effective is to be taken to mean that all losses are provided for in the 40 horsepower available.

Ques. 7.—Two drill holes 1 mile apart are put down to a seam of coal; the depth of the first is 634 feet and that of the second 850 feet; the surface of the former is 25 feet above the top of the later; what is the inclination of the coal seam between the two points measured in inches per yard?

Ans.—Since the shallow hole is started at a point 25 feet above the deep hole, the latter strikes the seam at $850+25=875$ feet below the surface at the former. The difference in the elevation of the seam at the bottom of the two holes is $875 - 634 = 241$ feet, and this is the dip in 1 mile. The dip per yard (there being 36 inches in a yard) may be found by proportion and is $5,280 : 241 = 36 : x$, or 1.65 inches per yard.

Ques. 8.—If the anemometer records a velocity of 800 feet a minute in the intake airway of a mine where sectional area measures 8 ft. × 10 ft. and the thermometer shows a temperature of 32° F., what should be the volume of air passing in this same airway per minute at a point where the temperature has risen to 60° F.?

Ans.—The volume of the intake air is $800 \times (8 \times 10) = 64,000$ cubic feet per minute. The expanded volume of the air may be found from the formula $V = \frac{460+T}{460+t} \times v$, in which T and t are the higher and lower temperatures and V and v, the volumes at T and t. Making the substitutions we have, $V = \frac{460+60}{460+32} \times 64,000 = 67,642$ cubic feet.

It should be noted that the size of the airway remaining the same this increased quantity will require a velocity of $67,642 \div 80 = 845$ feet per minute.

Ques. 9.—What will be the difference in strength of two pitch-pine timbers each 9 feet long and supported at both ends, the one being 10 in. × 10 in., and the other 8 in. ×12 in., placed on edge.

Ans.—When the span is the same the strength of the beams will be proportional to the breadth multiplied by the square of the depth. This, in the one case is $10 \times 10^2 = 1,000$; and in the other is $8 \times 12^2 = 1,152$. Hence, the strength of the beams is as 1,000 to 1,152, the 8″×12″ beam being 15.2 per cent. stronger than the 10″×10″ beam.

Ques. 10.—In case of a squeeze occurring in a mine under your charge, at what stage of its progress would you consider yourself justified in stopping operations and withdrawing the workmen?

Ans.—It is practically impossible to state any definite time at which the men should be ordered from the mine. When a squeeze begins, all efforts are directed toward securing a break of the overlying rocks so that the weight upon the pillars may be removed. To this end, outlying pillars are drawn back or robbed as rapidly as possible, props are pulled and the roof is allowed to fall or is blasted down, and heavy packs or cribs of stone or timber are built to increase the strength of the larger pillars which have been selected as being sufficiently strong to produce a break. All this is dangerous work, but not necessarily so dangerous as to warrant the withdrawal of the men. As a general rule work at the face of the rooms should be stopped as soon as the squeeze is so severe that the operations mentioned above are necessary to produce a break. If the roof is exceptionally weak, it may be advisable to call out the men before active steps to break to the surface become necessary. On the other hand, it is seldom if ever necessary to call out the men from other sections of the mine than those actually affected by the squeeze. Thus, it is apparent that the proper time to withdraw the men depends on local conditions and each case must be decided by itself.

Ques. 11.—Find the rubbing surface of three airways each 6,000 feet long and all having the same area, 75 square feet. The forms of the three sections are as follows: The first, A, is rectangular, 5 feet high and 15 feet wide; the second, B, is square; and the third, C, is circular.

Ans.—The perimeter of the airway A is $(2\times5)+(2\times15)=40$ feet. To find the perimeter of B, it is necessary to find the length of the side of the square whose area is 75 square feet. This is done by extracting the square root of 75 and is found to be 8.66 feet. The perimeter of B is, thence, $4\times8.66=34.64$ feet. To find the perimeter of C it is necessary to find the length of the circumference of a circle whose area is 75 square feet. This may be found from the relation,

$$\text{Circumference} = \sqrt{A \times 4\pi}$$
$$= \sqrt{75\times4\times3.1416} = 30.70 \text{ feet}$$

The several rubbing surfaces may be found by multiplying the perimeters by the length, thus: For A, $40\times6,000 = 240,000$ square feet; for B, $34.64 \times 6,000 = 207,840$ square feet; and for C, $30.70\times6,000 = 184,200$ square feet.

Ques. 12.—(*a*) State the conditions under which mine explosions are most frequently produced. (*b*) In what way do various kinds of coal dust influence the character of an explosion?

Ans.—The vast majority of disastrous explosions in British Columbia are what are known as "Dust Explosions"; that is, explosions of coal dust as such, or explosions of small quantities of gas the damage caused by which has been carried all over the mine by dust, and which gas explosions would have been local and relatively unimportant had it not been for the presence of coal dust. The conditions under which such explosions are apt to happen are encountered in any dry and dusty mine (other than one producing anthracite) when a small pocket of gas is present which may be ignited by an open light, a blown-out shot, a mine fire, or an electric arc (a short-circuiting of the electric current). Furthermore, any one of these four agents may ignite coal dust without any gas at all being present.

(*b*) Those coals which are soft and friable and, consequently, easily ground into fine powder which is carried all over the mine upon the air-currents are a greater source of danger than harder coals of the same chemical composition. Coals of the coking type ranging in content of volatile matter between 16 and 30 to 35 per cent. also supply a more dangerous dust than those with either less or more volatile constituents. Anthracite coal dust has not as yet served to propagate a gas explosion, on account of its low content of gaseous constituents and because that present is only driven off at a comparatively high temperature. The dust of lignite coals, although high in volatile matter, does not appear to readily lend itself to the propagation of an explosion. This is perhaps due to the cooling effect of the very large amount (20 per cent. and often more) of water always present in these coals, together with the fact that they are commonly high in ash, which is inert.

QUES. 13.—Find the I. H. P. developed by a 22"×18" engine making 200 revolutions per minute. The M. E. P. is 43.4 pounds per square inch.

ANS.—The area of the piston is $.7854 \times 22^2 = 380.13$ square inches. The speed of the piston is equal to twice the number of revolutions (200) per minute multiplied by the length of the stroke (18 in. = 1.5 ft.), or $2 \times 200 \times 1.5 = 600$ feet per minute. The work performed by the engine is equal to the area of the cylinder multiplied by the piston speed in feet per minute multiplied by the M. E. P. (mean effective pressure), or is $380.13 \times 600 \times 43.4 = 9{,}898{,}585.2$ foot-pounds per minute. Since 1 horsepower is equal to 33,000 foot-pounds of work a minute, this engine is of $9{,}898{,}585.2 \div 33{,}000 = 299.3$, say 300 I. H. P. (indicated horsepower).

QUES. 14.—Do you consider electricity as a motive power or lighting power dangerous in mines generating explosive gas? Give reasons for your answer.

ANS.—This question cannot be answered by a direct "yes" or "no," as it does not state the conditions under which electricity is to be used. The questions should state whether explosive dust is or is not present, whether direct or alternating current is to be used and the voltage, whether electricity is to be used to operate coal cutting machinery or only for haulage purposes (motors), whether the electric lights are of the portable type approved by the Bureau of Mines, or arc lamps or old-fashioned incandescents, and above all should clearly indicate whether the mine is assumed to be operated upon the best modern principles or in the ordinary manner.

The only danger (aside from shock to the men, and with this the question is not concerned) arising from the use of electricity is the possibility of producing a flame of sufficient intensity to ignite gas or dust. This danger is not peculiar to electricity and is present where open lights are used, where mine fires are possible and where the coal is shot down with powder. It would appear that in mines where blasting is permitted and where open lights are used if only on the haulage roads, that electricity does not add a new source of danger and but very slightly increases an already existing one. If the mine is operated upon strictly modern lines which demand that the percentage of gas in the main return as determined by daily analyses shall not exceed 1 per cent. and that the dust shall be treated to render it inert, there appears no good reason why electricity should not be used for all purposes as long as shot firing is permitted. When the mine is so gaseous that the use of hydraulic cartridges for blasting is absolutely necessary, then the use of electricity as a motive power should be prohibited and its application be limited to portable electric lamps of the type approved by the United States Bureau of Mines. But these unusual conditions have not as yet arisen in the mines of British Columbia.

QUES. 15.—If a water gauge of 2 inches passes 15,000 cubic feet of air per minute, what quantity per minute will a water gauge of 8 inches pass in the same airway?

ANS.—For the same conditions the volume of air in circulation is proportional to the square root of the water gauge reading. In this case we would have $\sqrt{2} : \sqrt{8} = 15{,}000 : x$, or $x = \frac{\sqrt{8}}{\sqrt{2}} \times 15{,}000 = 2 \times 15{,}000 = 30{,}000$ cubic feet a minute.

QUES. 16.—What is the highest percentage of explosive gas in which you deem it safe to carry on blasting operations in the mine?

ANS.—This is another question that does not seem capable of an unqualified answer. If no dust is present or the dust is watered so that an explosion is not possible through its ignition, there is no reason why blasting should not take place even in the presence of as much as 2 per cent. of gas. But under ordinary conditions of working, that is, where there is a possibility of the dust being an added source of danger, it does not seem advisable to permit blasting when the amount of gas is much, if any, over 1 per cent On the other hand if permissible powders are used and are electrically fired in properly placed and tamped holes, the seam having been undercut or sheared, firing is proper in a much higher percentage of gas than would be the case if black powder is used and shooting off the solid is practiced.

QUES. 17.—What horsepower is required to pass 70,000 cubic feet of air per minute when the water gauge reading is 9 inches?

ANS.—If q is the quantity of air passing in cubic feet a minute and i is the water gauge reading in inches the horsepower may be found by substituting in the formula, H. P. $= \frac{q \times 5.2 \times i}{33{,}000}$. From this, H. P. $= \frac{70{,}000 \times 5.2 \times 9}{33{,}000} = 99.3$ horsepower, about.

QUES. 17.—(*a*) What are similar figures? (*b*) Define the coefficient of friction as used in mine ventilation. (*c*) Define power and work.

ANS.—(*a*) Similar figures are those in which, when superimposed upon

one another, the sides of the one are parallel to the sides of the other and the angles of one are equal to the angles of the other and are similarly placed. (*b*) The coefficient of friction is the resistance in pounds offered by a surface 1 square foot in area to the passage of an air-current having a velocity of 1 foot per minute. (*c*) Work is something accomplished by a force acting through a certain distance. The unit of work is the foot-pound, and is equivalent to the energy required to raise a weight of 1 pound through a distance of 1 foot, or what is the same thing, is equal to the energy developed by a weight of 1 pound falling through a distance of 1 foot. Power refers to the ability to accomplish work in a certain time. Thus, it requires $2,000 \times 100 = 200,000$ foot-pounds of work to hoist 1 ton 100 feet; and the work is the same whether it is done in 10 seconds or 10 days, but the power is vastly different. The unit of power is 1 foot-pound per minute, or the power required to raise 1 pound 1 foot high in 1 minute. In dealing with hoisting and haulage problems, the horse-power is the common unit employed and is the power required to raise 33,000 pounds 1 foot high in 1 minute.

Ques. 18.—A gravity plane has a grade of 10 per cent.; it is 2,500 feet long, and the rope attached to the empty cars at the foot of the incline weighs 4,200 pounds; a loaded car weighs 4,000 pounds, and an empty one 1,800 pounds; what is the number of cars that must be run in a train to overcome the resistance of the rope at the start of the run?

Ans.—The length of the incline, 2,500 feet, is not concerned in the solution of the problem. If L = weight of descending loaded car in pounds; E = the weight in pounds of the ascending empty car; R = the weight of the hauling rope; a = sine of angle of slope; $\frac{1}{10}$ = the coefficient of friction; and N = the number of cars in the trip, we may deduce two formulas as follows:

Force to overcome weight and friction of rope $= aR + \frac{R}{40}$.

Available gravity force due to coal $= a\ (L-E) - \left(\frac{L+E}{40}\right)$.

Substituting in the first formula for R, 4,200 pounds, and for a, $1 \div 10 = .1$*, we have $.1 \times 4,200 + \frac{4,200}{40} = 420 + 105 = 525$ pounds, as the force necessary to overcome the weight and friction of the rope.

Substituting in the second formula for L, 4,000 pounds, and for E, 1,800, and for a, .1 as before, we have, $.1\ (4,000 - 1,800) - \frac{4,000+1,800}{40} = 220 - 145 = 75$ pounds = available gravity force due to one car of coal. If one car of coal yields 75 pounds of force and it requires 525 pounds, to overcome the weight and frcition of the rope, it will take $525 \div 75 = 7$ loaded cars for this latter purpose. It will be noted that the assumed friction of $\frac{1}{10}$ may not be the right one, and that any change in this coefficient will affect the number of cars required to start the rope. As, upon the assumption of $\frac{1}{10}$ for the friction, seven cars just offset the resistance, it would be better to count upon eight cars in practice.

Ques. 19.—(*a*) What kind of a mining machine is best suited for working seams of coal containing considerable amounts of iron pyrites and having rolls in the bottom? (*b*) What restricts the size and weight of mining machines? (*c*) What are the dangers attached to machine mining, and how would you guard against them?

Ans.—(*a*) A machine of the pick or puncher type is best suited under the described conditions, as it can cut around sulphur balls, into the trough between rolls, etc. It may be of the standard type operated by compressed air, or, where electricity is available, may be of the Pneumelectric type. (*b*) The size (height) of a machine is limited by the thickness of the seam in which it is to be used, and the weight by the pitch of the seam, chiefly, and in a lesser degree by the thickness. It is apparent that in thin and pitching seams much smaller and lighter machines must be used than in thick and flat ones. (*c*) There are no particular dangers incident to operating the machines that may not be overcome by the exercise of ordinary care. Accidents with pick machines are rare, as they are simple in construction and have few exposed moving parts. The bursting of an air pipe is a simple matter and not attended with danger. In chain machines, electrically operated, there are the usual dangers or risks attendant upon the use of this power. These may be overcome by proper insulating, handling, etc. Having many moving parts, there is the constant danger of the operator or helper being caught in the chain, etc., and in some states protection against this is provided in the laws, which require the chain and other moving parts to be covered while in motion. In the old type of chain breast machine, if used in mines having a bad roof, there was the ever-present danger of falling rock. This was due to the fact that the machine had to be run out of the cut and moved laterally across the face every time it had cut its own width, so that props could not be set within 8 to 12 feet of the face, the distance depending upon the type and size of machine. This danger did not and does not arise from the use of pick machines (either compressed air or electrically operated) and in chain machines has been overcome by the introduction of short-wall cutters. These make a continuous cut across the face, propelling themselves by a rope or chain fastened to either rib. As they remain under the coal until the cut is completed, the first row of props may be set within 5 to 8 feet of the face.

*This is really the tangent, but for small angles the sine and tangent are, for practical purposes, the same.

The poem below was written by a miner in Harlan County, Ky., on the side of one of the new, steel hopper, 100,000 pounds capacity cars of the L. & N. R. R.

"They built me for a battleship,
But I wouldn't carry a gun;
So they use me for a coal car,
And I carry fifty ton."

Practical Talks on Coal Mining

For men who desire information on Coal Mining and related subjects presented in a simple manner

Mechanics of Mining

An Explanation of the Principles Underlying Calculations Relating to Engines, Pumps, and Other Machinery

By R. T. Strohm, M. E. (Continued from December)

ALTHOUGH air is comparatively light and therefore easily set in motion, the construction of the fan must be stiff and strong to reduce swaying and vibration. The blades, particularly, must be firmly attached and supported, and should also be well braced. A common way of connecting the blades to the driving shaft is to fasten a pair of spiders to the shaft and then to connect the fan wheel to these spiders by straight, rigid, radial arms. This is the construction of the fan shown in Fig. 40, the spiders being shown at *i* and one of the arms at *f*.

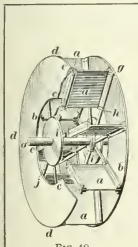
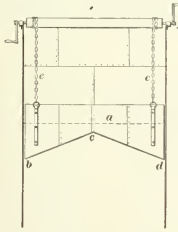


Fig. 40



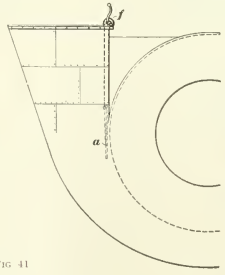


Fig. 41

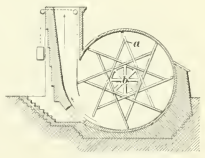


Fig. 42

This construction, although it gives firm and direct support to the blades, has one serious disadvantage. Each spider is located directly in line with the side plate of the fan wheel and is therefore right in the center of the intake opening on each side. As a result, the inflow of air is obstructed, and the area of the intake opening is reduced. Instead of an opening having the full size of the circle *c c c*, the opening through which the air enters the fan at one side is simply the ring-shaped area between the spider *i* and the side plate *b*.

The objection to this reduction of area of intake opening is that it decreases the capacity of the fan. If all the air passages are large, the air will flow with the least amount of resistance; but if the spider and the arms occupy a considerable part of the intake opening, less air will be able to enter in a given time, and the discharge of the fan will be correspondingly decreased.

The same result will occur if the passages through which the air flows contain sharp bends, angles, or surfaces that break up the air-current and cause eddies. Therefore, to secure the greatest amount of air with a given driving power, the fan and the casing should be constructed so as to make the flow of air as smooth and free from eddies and obstructions as possible.

Sometimes the ventilating fan is supplied with a shutter, which is a sliding plate or door suspended against the vertical face of the chimney, as shown at *a*, Fig. 41. The object of using a shutter is to reduce the vibrations set up in the fan. The blades and other plates in the fan wheel expose large surfaces to the action of the air pressure, and if the air strikes abruptly against sharp angles, so that eddies and cross-currents are produced, the rapid changes of air pressure may cause the blades and plates of the fan to vibrate or sway.

As the fan rotates, the tips of the

blades pass the point of cut-off very rapidly, and the effect of trapping the air between the blades and the housing at this point is very much like striking a series of rapid blows on the air with the blades. This may cause vibrations in the fan wheel.

Again, the source of the vibrations may be outside the fan itself, at some distance from it. If the air-current after leaving the fan is disturbed and broken up by bends or surfaces

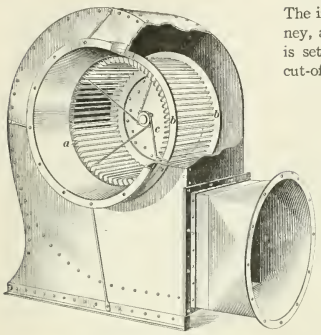


Fig. 43

poorly arranged, the rapid changes of pressure thus caused may be transmitted back through the air itself to the fan and may cause vibrations in the fan.

As shown in the illustration, the shutter is suspended at the point of cut-off, and its lower edge *b c d* is cut V-shaped. When the blades pass the end of the shutter, the air is not cut off at once along the entire width of the fan. Instead, the cut-off begins at the lower points *b* and *d* and is not complete until the blade passes the top of the notch at *c*. This gradual cut-off tends to decrease the shock and so reduces the vibration.

The shutter is suspended by two chains *e* wound on a windlass *f*; thus, by turning the handles, the shutter may be raised or lowered until the correct adjustment is obtained to reduce the vibration to a minimum. The use of a shutter to prevent vibration is becoming less common, however, because modern fans are constructed and proportioned with a view to eliminating vibration. A disadvantage of the shutter is that it reduces the area of the opening from the spiral passage to the chimney and thus causes a decrease in the capacity of the fan.

It will be noticed that the chimney of the fan grows larger in the direction of flow of the air, this being accomplished by sloping the outer face that joins the spiral housing. The inner, or back, face of the chimney, against which the shutter rests, is set vertically above the point of cut-off. The reason for sloping the outer face is that it forms a continuation of the spiral housing and changes the direction of flow of the air gradually; whereas, if it were vertical, the air would strike almost squarely against it and would form eddies or produce vibrations.

One of the earliest improved forms of centrifugal fan was the Guibal fan, the construction of which is shown in Fig. 42. The fan blades are arranged on two star-shaped frames *a* that are bolted to spiders *b*, one at each side of the fan. The fan blades are bolted to the outer ends of the bars, and the fan wheel rotates in the direction of the curved arrow. The inner end of each bar is carried across the spider and forms a brace for the outer end of another bar, thus giving an inexpensive construction. But the space occupied by the bars and the spider at the center reduces the area of the intake opening, obstructs the inflow of air, and thus decreases the efficiency of the fan.

A point to be noted in connection with this fan is that the blades are not radial; that is, they do not stand straight out from the center of the fan shaft. The bars to which they are bolted are set to one side of the center and, as a result, the blades are inclined backwards at the tips, when compared with the direction in which the fan turns. Consequently, when the air enters at the center and is struck by the blades, there is less shock than in the case of a fan having radial blades, as shown in Fig. 40, and the air flows more smoothly over the blades and through the fan. This advantage, however, is partly offset by the disadvantage that the force by which the air is thrown outwards is less when the blades are inclined than when they are radial.

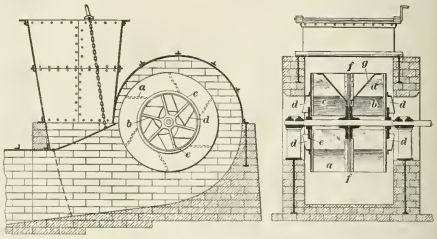


Fig. 44

One of the peculiar features of the Guibal fan shown in Fig. 40 is that the housing is circular and fits close to the ends of the fan blades for three-fourths of the way around the fan. From this point it is spiral and connects with the sloping side of the chimney. It did not take long to determine that this was not the best construction possible; consequently, later improved forms of this make of fan have spiral housings that surround a greater part of the fan wheel than the housing illustrated. The result is that the improved forms are more efficient than the old.

Another form of centrifugal fan used in mine ventilation is the Capell fan, shown in Fig. 44, in which the left-hand view is a side view and the other is a vertical cross-section

through the fan-shaft bearings. This fan has a double set of blades or wings. The outer set *a*, shown by the dotted lines, are curved and extend from the intake circle to the outer edge of the fan. The second set *b* extend inwards from the intake circle toward the center of the fan and are joined to the outer set by the ring *c*.

The outer set of blades, by which the air is thrown out from the fan into the spiral housing, are placed parallel to the fan shaft; but the inner set of blades are inclined at an angle to the shaft. Also, a series of curved vanes or scoops *d* are attached to the arms *e*, and these are bent forwards in the direction in which the fan rotates. They catch the air as the fan turns and direct it inwards through the intake opening against the blades *b*, which in turn lead it smoothly to the outer blades *a*.

At the middle of the fan shaft two hubs or flanges are placed back to back and a circular steel plate *f* is firmly bolted between them. This plate extends from the shaft to the outer edge of the fan. Diagonal braces *g* are riveted to this plate and to the blades *a* to give them firmness and to prevent vibration. The arms *e* are bolted to spiders on the shaft and to the rings *c* at each side.

The Sirocco fan, shown in Fig. 43, differs from the preceding types in several particulars. In the first place it has a large number of very short blades *a* instead of a small number of long blades; that is, instead of 8 to 12 large blades, the Sirocco fan has 64 short blades. The blades are the full width of the fan and are riveted to two rings *b*, one at each side. One of these rings is fixed to a cone-shaped casting on the fan shaft and brace rods *c* are fastened to the casting and to the other ring to support it.

This fan, therefore, is open only at one side, or has only one intake opening, because the other side is closed by the conical casting. The driving shaft is keyed to the casting and the engine or motor that runs the fan may be placed at either side. If it is placed at the back, the shaft is not always carried through the fan; but if it is placed at the front, the shaft is carried out through the intake opening. As the shaft is comparatively small, the intake area is not appreciably reduced. The intake opening is very large, and the blades occupy only a small space near the outer edge of the fan, so that the resistance to the flow of air through the fan itself is small.

The principle of operation is the same as that of other centrifugal fans. When the fan is started, the air between the blades is thrown out by centrifugal force, and a vacuum is prevented by air that flows in through the center of the fan. As the speed of the fan is increased, the rate at which the air is discharged is also increased. This fan and that shown in Fig. 44 are high-speed fans; that is, they run at much greater rotative speeds than the Guibal fan. However, they are of smaller diameter than a Guibal fan designed to produce an equal volume of air.

Electricity in Mines

The Kilowatt—Watt-Hours and Kilowatt Hours—Errors in Indicating Instruments Due to Static Charge

By H. S. Webb, M. S. (Continued from December)

THE watt is too small a unit for convenient use in expressing the output of large electric machines, so the kilowatt is generally used. One kilowatt is equal to 1,000 watts, or slightly over 1⅓ horsepower. For example, if a machine had a capacity of 75 kilowatts, it would mean the same as 75,000 watts, or a little over 100 horsepower.

To convert watts into kilowatts.

RULE I.—Divide the number of watts by 1,000.

To convert kilowatts into watts:

RULE II.—Multiply the number of kilowatts by 1,000.

The kilowatt is equal to $\frac{1000}{746}$ = 1.34 horsepower, but for rough calculations it is taken as 1⅓ horsepower, and the horsepower is taken as ¾ kilowatt.

EXAMPLE.—An electric machine has an output of 240,000 watts: (*a*) What is its output in kilowatts? (*b*) What is its output, in horsepower, approximately? (*c*) What is the output in horsepower, exactly?

SOLUTION.—(*a*) Applying rule I, 240,000 ÷ 1,000 = 240 kilowatts. Ans. (*b*) 1 kilowatt is approximately equal to 1⅓ horsepower; hence,

$$240 \text{ kilowatts} = 240 \times 1\tfrac{1}{3} = \frac{240 \times 4}{3}$$

=320 horsepower. Ans.

(*c*) Applying rule II, 240 kilowatts =240×1,000=240,000 watts; 1 horsepower =746 watts; hence, the exact output, in horsepower, is 240,000 ÷746=321.7. Ans.

Watt-Hours and Kilowatt-Hours. The joule, which is the regular unit of electrical work, is too small for convenient use, so that larger units have been devised for use in commercial work. A commonly used unit of work larger than the joule is the watt-hour, which is the amount of work done when 1 watt is expended for 1 hour. When the product of a number of watts or of a fraction of a watt multiplied by a fraction of an hour or a number of hours equals 1, the work done equals 1 watt-hour. Watt-hours = watts × hours. A still larger unit of work is the kilowatt-hour, which is the amount of work done when 1 kilowatt is expended for 1 hour, ½ kilowatt for 2 hours, and so on; that is, kilowatt-hours = kilowatts × hours.

EXAMPLE.—A current of 10 amperes flows through a circuit for 2 hours; the pressure required to force the current through the circuit is 240 volts. Calculate: (*a*) the power expended, in watts; (*b*) the power expended, in kilowatts; (*c*) the power expended, in horsepower; (*d*) the total quantity of electricity passed through the circuit; (*e*) the amount of work done, in joules; (*f*) the work done, in foot-pounds; (*g*) the work done in watt-hours; and

(*h*) the work done in kilowatt-hours.

Solution.—(*a*) Watts = volts × amperes = 240 × 10 = 2,400. Ans.

(*b*) Kilowatts = $\frac{\text{watts}}{1,000} = \frac{2,400}{1,000} = 2.4$. Ans.

(*c*) Horsepower = $\frac{\text{watts}}{746} = \frac{2,400}{746} = 3.22$. Ans.

(*d*) Coulombs = amperes × seconds = 10 × 7,200 = 72,000. Ans.

(*e*) Joules = amperes × volts × seconds = 10 × 240 × 7,200 = 17,280,000. Ans.

(*f* Foot-pounds = joules × .7373 = 17,280,000 × .7373 = 12,740,544. Ans.

(*g*) Watt-hours = watts × hours = 2,400 × 2 = 4,800. Ans.

(*h*) Kilowatt-hours = kilowatts × hours = 2.4 × 2 = 4.8.

Or, kilowatt-hours = $\frac{\text{watt-hours}}{1,000} = \frac{4,800}{1,000} = 4.8$. Ans.

Error in Indication of Instruments Due to Static Charges.—A considerable error in the indication of measuring instruments of any kind may be caused by a static charge established upon the glass window of the instrument when cleaning it with a dry cloth or even with the hand. Rubbing the glass with a dry cloth or the hand establishes on the glass a positive charge, which in turn induces a negative charge on the pointer of the instrument. The two charges being of opposite character attract each other thereby affecting the indications of the instrument. Although the charge would vanish sooner or later, it may be neutralized in a moment by passing a lighted match back and forth in front of the charged glass. The pointer is usually in metallic connection with the metal case of the instrument. When a lighted match is brought near the glass the smoke and light, by making the air near the metal case and the glass a better conductor, cause the two charges to unite and neutralize each other. The flame need not be brought nearer to the glass than 1 inch and need only be applied for a short time so that there will be neither smoking nor heating of the glass.

Mine Ventilation

Construction and Use of Regulators—Conditions Which Require Their Use—Where They Should be Placed

Written for The Colliery Engineer. (Continued from December)

JUST as water seeks the easiest and quickest course down hill, so does the air in a mine naturally follow the shortest and easiest path from the intake to the

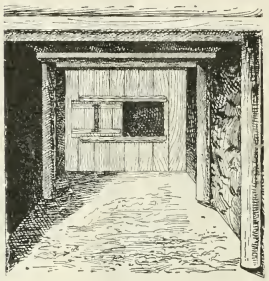


Fig. 13

fan. But it generally happens that this natural short course for the air is not the one the conditions of mining require it to travel. For example, 100 men working on a very long heading will receives less air than 10 men working on a very short one if the air is allowed to travel its natural route; whereas, they should receive very much more. In order to distribute the right quantity of air to the various headings, regardless of the amount they would naturally receive, artificial obstructions are placed in those through which the air naturally travels most easily.

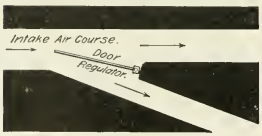


Fig. 14

In this way the resistance is increased, less air passes through them and more travels along the airways offering more natural resistance. These artificial obstructions are known as regulators, and are of two general types.

The box regulator shown in Fig. 13 is the common type and consists of a solid board stopping *a*, or of a door, with a hole in the center and provided with a shutter *b*, that can be slid over the opening so as to regulate the size of the passage through which the air is allowed to pass. By this means the volume of air passing through the regulator is made greater or less as desired. The box regulator is generally placed at the inner end of the air-current that it controls, on an entry or air-course that is not used as a haulage road, so as not to interfere with the passage of cars.

Regulators are very often made by fixing a piece of scantling across the entry near the roof and another near the floor. To these are nailed a sufficient number of narrow strips of wood to reduce the width of the entry to that necessary to pass the desired volume of air. While the size of the opening in this and the box regulator necessary to pass any volume of air may be calculated, this is commonly determined by trial, adding or taking away strips of wood or closing or opening the shutter as may be necessary.

The door regulator, Fig. 14, is a door provided with a set lock, so that it may be secured in any desired position. It is always placed at the mouth of an entry, and is so arranged that it may be swung to one side or the other, so as to increase or decrease the quantity of air passing in either entry. The angle at which this door is set is commonly determined by trial.

Chief of Department of Mines of West Virginia, has appointed R. B. Cobb, as inspector of the fifth district.

NEW MINING MACHINERY

Pocket Mining Hygrometer

The use of the hygrometer is in its infancy for observations in coal mines and while the complete rotary sling hygrometer is undoubtedly the most accurate for obtaining humidity readings, it is too delicate an instrument to carry around underground. The hygrometer shown in Fig. 1 has its novelty in the carrying case which converts it into a pocket instrument that is not liable to become broken when carried about in the mine. The wet and dry thermometers are inserted in each side of a split cylindrical case which is readily closed or opened by a handle. It is easy to swing but it is not so quick as the complete rotary sling hygrometer. The thermometers are mounted on springs to lessen the danger of breakage, and that, with the case, make a handy arrangement for underground observations. It is manufactured by Davis Instrument Manufacturing Co., Baltimore, Md.

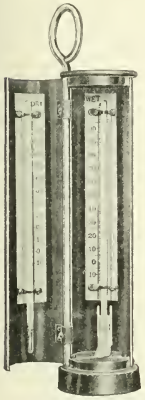


Fig. 1. Hygrometer Open

A New Recording Hygrometer

Recording hygrometers, giving a single record of the relative humidity have been in use for a long time.

Engineers have appreciated the distinct advantage of having a record of both the dry-bulb temperature and the wet-bulb temperature independently but simultaneously on the same chart. Such an instrument has the added advantage in the ease with which its accuracy can readily be checked with a standard thermometer at all times. The importance of proper conditions of temperature and humidity is being more and more appreciated in its effect on coal dust.

To meet the growing demand for an accurate and reliable wet and dry bulb recording thermometer, The Industrial Instrument Co., Foxboro, Mass., has designed the recording hygrometer illustrated in Fig. 3. It consists of two sensitive bulbs mounted in tandem back of the case, the wet bulb being jacketed and kept moist by maintaining water at a constant level in a trough beneath the bulb.

The pen arms are attached directly to shafts concentric with the helical tube bulbs. The case is mounted on a swivel bracket enabling the swinging of the instrument at right angles to the wall or support, and giving easy access to the inverted glass bottle serving as a water reservoir. It is made in three sizes, viz., 8-inch, 10-inch, and 12-inch, corresponding to the standard sizes of Foxboro recorders and to cover ranges between freezing point and boiling point of water (32° to 212° F. or 0-100° C.).

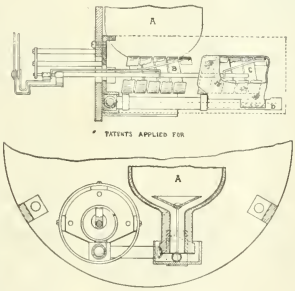


Fig. 2

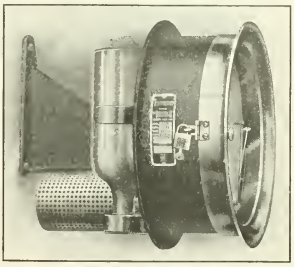


Fig. 3. Recording Hygrometer

The principle of the construction of the recording hygrometers is shown in Fig. 2. In the cut *A* represents the reservoir, the tube *B*, the dry bulb which records the atmospheric temperature, and *C* the wet bulb which is covered with a special jacket leading down into trough *D*, containing water. The bulb *C* is always cooler than *B* due to the evaporation of the water. The evaporation increases or diminishes according to the amount of moisture in the air. Taking the difference between the two thermometer readings and consulting the table that is sent with the instrument the relative humidity is quickly ascertained.

New Two-Stage Air Compressor

The Delaware, Lackawanna & Western Railroad Co., has recently installed in Keyser Valley near Scranton, a Corliss, cross-compound, two-stage air compressor, an illustration of which is shown in Fig. 4.

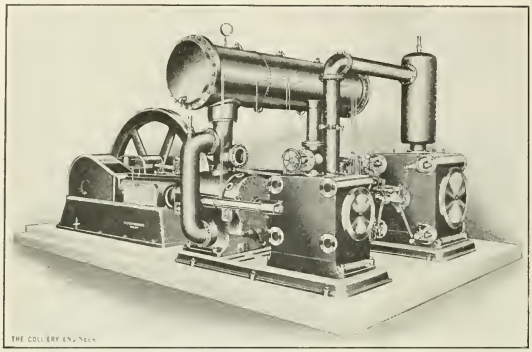


Fig. 4. Cross Compound Two-Stage Air Compressor

The high-pressure (H. P.) steam cylinder is 19 inches diameter, the low-pressure steam cylinder (L. P.) is 31 inches diameter, the common stroke being 26 inches. The low-pressure air cylinder is 26 inches, the high pressure 17 inches in diameter, with the same stroke as the steam pistons.

The low-pressure air cylinder delivers to the large intercooler shown above the engines, which cools the air practically to that of the atmosphere before it is delivered to the high-pressure air cylinder.

Variable delivery of air to meet the demands is provided for by the application of a sensitive-speed governor and air-pressure regulator operating on the steam-valve gear to momentarily change the point of cut-off by a sufficient amount to allow the compressor to assume a speed to correspond to the air load. As this load is constant per stroke the M.E.P. and consequently the point of cut-off of the steam end is practically constant regardless of the speed, giving an opportunity for the employment of compound cylinders, exactly proportioned for the steam conditions, and permitting of economies far exceeding those of constant speed power engines. The compressor, which is capable of displacing 2,500 cubic feet of free air per minute at 135 revolutions per minute, was constructed by the Chicago Pneumatic Tool Co.

Feeding Graphite to Boilers

The United States Graphite Co., of Saginaw, Mich., has perfected an apparatus whereby finely divided graphite may be introduced into boiler feedwater. It is claimed that graphite will prevent the impurities in boiler feedwater from hardening, because it settles and mixes with those impurities. It also coats the tubes and surfaces exposed to scale-forming material and prevents it from fastening to the boiler. The mixed precipitate then finds its way to the mud drum and is blown out daily. The company claims that $\frac{3}{4}$ pound of graphite fine-ground and air floated is sufficient for each 100 horsepower developed in 10 hours, or on a basis of evaporation, 3 ounces of graphite for each 1,000 gallons of water evaporated.

The apparatus is shown attached to a boiler feed-pump in Fig. 5. It is said to furnish a steady gradual feed, which permits the graphite to mix with the impurities before they have an opportunity to harden to the boiler tubes and shell.

This feeder has a reservoir which is so equipped with valves that it may be entirely closed and all water pressure shut off. The water valve is then opened so that the ordinary city water pressure is applied to the reservoir of the feeder and then this combination of water and graphite is fed through an outlet valve at the bottom of the reservoir into the feedwater on to the suction side of the pump. This valve permitting the water saturated with graphite to pass through can be readily adjusted by watching the water glass to see how fast the graphite is traveling. With a little experience the engineer soon becomes able to regulate this valve so that there will be, through the hours of operation, a constant leaching of graphite going into the boiler with the feed until the contents of the reservoir become exhausted when the valves are again closed and by

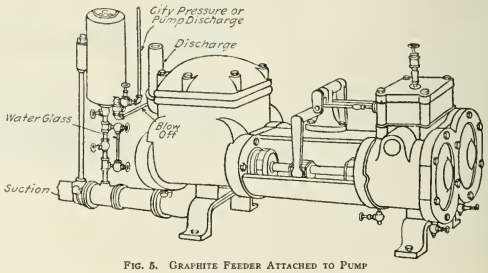


Fig. 5. Graphite Feeder Attached to Pump

means of a drain valve which is on the reservoir it is emptied of the clear water remaining in it and then again filled with graphite and regulated as before.

After a little experience and measuring of time, the valve through which the graphite passes into the feedwater can be set and marked so that the engineer will know just where to open it each time in order to give his dose as specified.

The cost of keeping boilers clean with graphite of the right sort is a great deal less than the cost of doing so by using the ordinary run of chemically acting compounds. In many plants cleaning cost has been reduced to less than one-half what it had been formerly.

As graphite would have no direct action on the sulphur in water, softeners would have to be continued, but it would probably prevent the oxides forming scale after water has been softened.

Kewanee Air-Pump Union

The National Tube Co., of Pittsburg, Pa., is manufacturing an air-pump union which although similar in construction to the Kewanee union is designed for use in connection with

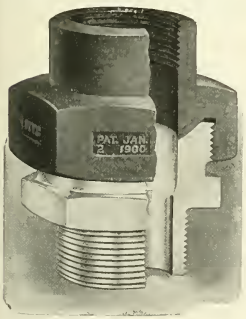


Fig. 6. Kewanee Air-Pump Union

air-compressor pipe lines. There is a brass connection with an iron connection at the ring, and as brass and iron will not rust together, the union, it is claimed, can be connected and disconnected many times without trouble. Where a gasket union is used in making connections with air compressors or compressed-air pipes, there is more or less trouble with their corrosion if of metal, blowing out, if fiber or rubber, or, if the particular sized gasket is not on hand, constructing one to fit and make an air-tight joint. By the brass to iron ball joint seat in the Kewanee air-pump union no gasket is needed. Every union is tested to 125 pounds compressed air under water to ascertain if it be air-tight and prevent failures in service. Users of compressed-air locomotives and those who use air brakes will appreciate this union, as much as those who use compressed air for drilling purposes.

A Lubricating System

It costs some mines twice as much as others to lubricate the steam cylinders of hoists or other engines because the right lubricant has not been selected, and even the wrong kind is not being properly used. A system which is said to overcome lubricating difficulties, and to be particularly adapted to coal mine work, consists of the Ohio cylinder grease and the lubricators that feed it.

The grease is a pure petroleum lubricant, having a high fire test and great viscosity. It is so concentrated that the makers claim that 1 pound (or pint) does more and better work than 5 or 6 pints of ordinary cylinder oil. It contains no acid, foul animal matter, or carbonizing admixtures, and is adapted to all steam pressures.

This grease is fed to the cylinders by specially designed lubricators, which are loaned for the purpose, and kept in repair free by the manufacturers. These lubricators automatically heat the grease, feed it in very small drops, and then atomize or vaporize each of these drops, thoroughly mixing them with the steam before it enters the cylinder.

This enables the steam to easily carry the lubricant, and deposit a thin, uniform film or veneer on all parts of the valves and cylinder. Every atom is placed right where it is needed, and because of the vis-

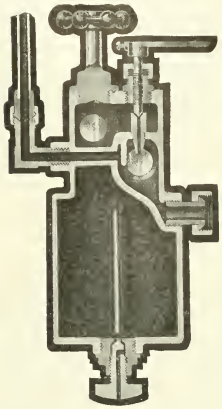


Fig. 7. Ohio Grease Feeder

cosity of the grease, it remains there until it is used.

The Ohio Grease Co., at Loudonville, Ohio, who manufacture both the grease and the lubricators, offer to furnish testing material under a plan which enables the system to be tried out without expense.

TRADE NOTICES

The Wolf Safety Lamp Co. of America, Inc., has opened offices in New York City at 47 and 49 West Street. This company has taken over all rights and patents for selling and manufacturing all Wolf products on the American continents and has as its president and directing head, Mr. G. A. Creutzburg, formerly identified with the Draeger Oxygen Apparatus Co. The Wolf Lamp Co. henceforth will also act as special selling agent for the Draeger Oxygen Apparatus Co.

The Draeger Oxygen Apparatus Co., of Pittsburg, will also act as

special selling agent for the Wolf products. A complete line of the Wolf miners safety lamps burning naphtha, oil, or acetylene, Wolf electric safety lamps, and Wolf open acetylene lamps, both to be used as hand or cap lamps, will be carried in stock, at the warehouse of the Wolf Safety Lamp Co. in New York City. A complete supply of extra parts and machinery for the maintenance of Lamp Cabins will also be carried.

Leschen's Enlarged Plant.—Since starting in business 56 years ago, the A. Leschen & Sons Rope Co., of St. Louis, have found it necessary every few years to increase their plant in order to meet the growing demand for their products. They have recently completed a factory building that will enable them to approximately double their output. Their factory buildings now cover over 30 acres, and in addition to these they have a large warehouse in St. Louis, as well as branch stores in New York, Chicago, Denver, Salt Lake City, and San Francisco, and are represented by over a hundred agents in different parts of the country.

A Fan Patent Decision.—On October 9, 1913, a decision was handed down by Judge Ray, of the United States District Court for the Southern District of New York, sustaining the fundamental Davidson patents owned by the American Blower Co., of Detroit, covering fans of the multiblade or squirrel-cage type, being reissued patents Nos. 12796 and 12797.

This suit was brought to suppress a claimed infringement by the B. F. Sturtevant Co., of Hyde Park, Massachusetts. The case was argued in January, 1913, before Judge Ray of New York.

The defendant contended that the patents were invalid, the prior art being cited and applied. The defendant also contended that its multivane fan was not an infringement.

The Court holds that the Davidson invention is an improvement or advance in the art, involving discoveries, and decided that the reissued patents were properly reissued to the Sirocco Engineering Co. (now consolidated with the American Blower Co.), as assignee. On the question of infringement, the Court granted a decree for the complainant, with an injunction as prayed, and with costs.

ANNOUNCEMENTS

The Toronto branch of the Canadian H. W. Johns-Manville Co., Limited, announces its removal to No. 19 Front Street, East. This new store and warehouse has a floor area of approximately 35,000 square feet, and is situated in the heart of the wholesale district.

The Sullivan Machinery Co., has removed its branch office at El Paso, Texas, to new quarters at Rooms 511 and 512 Mills Building, El Paso. The old quarters on San Francisco Street, will be maintained as enlarged warerooms, in which compressors, drills and their parts are carried in stock. The company also announces that Mr. John Oliphant, for many years president of the Harris Air Pump Co., of Indianapolis, has joined its engineering staff, and will have charge of its pneumatic pumping department.

Catalogs Received

Formastat Mining Co., Chemical Bldg., St. Louis, Mo. Formastat Rustless Coating, 12 pages.

Independent Powder Co., Joplin, Mo. Circular, "Frozen Dynamite."

Pennsylvania Crusher Co., Stephen Girard Bldg., Philadelphia, Pa. Bulletin 522, Coal Washery Losses Reduced to a Minimum, 4 pages; "Pennsylvania" Coal Cleaners, 16 pages; "Pennsylvania" Hammer Crushers, 32 pages.

The Draeger Oxygen Apparatus Co., 422 First Ave., Pittsburg, Pa. Circular, Draeger Helmets; Circular, "The Draeger Pulmotor Will Resuscitate."

Lunkenheimer Company, Cincinnati, Ohio. Lunkenheimer Regrinding Valves, 23 pages.

Buff & Buff, Jamaica Plains, Mass. The Buff Transit, 32 pages.

Sullivan Machinery Co., Chicago, Ill. Sullivan Single-Stage, Power-Driven Air Compressors, 11 pages; Sullivan Angle-Compound Power-Driven Air Compressors, 19 pages.

The Sackett Mine Supply Co., 162-164 North Third St., Columbus, Ohio. Electric Rope Haulage Machines, 8 pages.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y. "Little David" Pneumatic Drills, 24 pages.

Ohio Brass Co., Mansfield, Ohio. Circular O-B Mine Trolley Harp.

Ohio Grease Lubricant Co., Loudonville, Ohio. A Catalog and and Price List of Ohio Lubricating Greases, 8 pages.

C. O. Bartlett & Snow Co., Cleveland, Ohio. Catalog No. 42, Triumph Crushers, Feeders, Pulverizers, 32 pages.

U. S. Graphite Co., Saginaw, Mich. "What Users Say About It," 63 pages.

Platt Iron Works, Dayton, Ohio. Platt High-Lift and Turbine Pumps, Bulletin 755, 11 pages.

Canton-Hughes Pump Co., Ohio. Catalog No. 25, Steam Pumps and Hydraulic Machinery, 120 pages.

Davis Instrument Mfg. Co., Inc., 110 W. Fayette St., Baltimore, Md. Circular, U Mine Water Gauges.

Milwaukee Locomotive Mfg. Co., Milwaukee, Wis. Modern Haulage, 40 pages.

The Fulton Pit Car Co., Canal Fulton, Ohio. The Fulton Pit Car, 41 pages.

J. C. Buckbee & Co., First National Bank Bldg., Chicago, Ill. Bulletin No. 1028, Type "C" Universal Excavator, 8 pages.

Monighan Machine Co., 2016-2030 Carroll Ave., Chicago, Ill. Drag Bucket Excavators, 63 pages.

General Electric Co., Schenectady, N. Y. Bulletin No. A4178, Three-Phase Induction Motor Panel, for Controlling Forms K, L, M, and P Motors, 11 pages; Bulletin No. A4185, Single-Phase Induction Motors, Type KS, 7 pages.

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXIV—No. 7 FEBRUARY, 1914 Scranton, Pa.

Alphabetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68

LIBRARY

BEGINNING WITH THIS ISSUE The Colliery Engineer will publish a series of illustrated articles describing the various precautions employed in Great Britain, France, Belgium, Germany, and Austria, and in the various coal fields of America for

The Prevention of Coal Dust Explosions

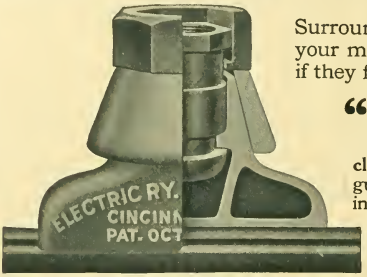
For more than quarter of a century The Colliery Engineer has been publishing evidence that ***proved*** the explosibility of coal dust. These new articles deal entirely with the ***precautions*** taken to prevent such explosions. They have been written especially for The Colliery Engineer, by the best authorities of the various countries; and those requiring translation have been translated by men capable of correctly expressing the ideas of the writers.

In this number appears the first of the series:

French Coal Dust Precautions

By M. Pol Dunaime, Engineur des Mines, Conde, Nord France.

Make Your Trolley Lines Safe



Surroundings have much influence on the work your men do. They may have the best tools but if they feel *unsafe* they are handicapped.

"SURE GRIP"

clamps keep live trolley wires in their place—safeguard your men from the dreaded danger of falling and hanging wires. The "Sure Grip" clamp is positive. Made in all sizes: 1-0 to 4-0, in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Superior Supply Co.
Bluefield, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine and Smelter Supply Co.
El Paso, Texas

Mine & Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

Arthur L. Ware
Jellico, Tenn.

HAZARD WIRE ROPE

FOR EVERY PURPOSE

HAZARD MFG CO.
WILKES-BARRE, PA.

NEW YORK 50 DEY STREET. PITTSBURG FIRST NTL BANK BLDG. CHICAGO 552 WEST ADAMS ST.

INSULATED WIRES AND CABLES

FOR

Light, Power, Telephone, Telegraph
Mining Machines and Locomotives

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah (Office Atlanta) Cleveland
San Francisco Los Angeles
Seattle Portland, Ore.

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

For Mines and Minerals

Vol. XXXIV—No. 7 FEBRUARY, 1914 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1881

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE, 15,000

TABLE OF CONTENTS

Editorial—
American Institute of Mining Engineers in Anthracite Region—The Prevention of Coal-Dust Explosion—Tests of Bering River Coal Unfavorable—Roof Support—Strikes in Violation of Contracts—Proposed Mining Legislation in Ohio 395
Personals 398
Coal Fields of Lower Park, Alberta, by Frank E. O'Neal 399
Coal Breaker at Whitwick Colliery 402
The Old Freibergers in America 402
French Coal-Dust Precautions, by Pol Dunaime 403
Coke-Oven Gas for Power Purposes 407
Basic Coke, by J. R. Campbell 409
Ohio Mine Rescue Car, by Wilbur Greely Burroughs 411
The Selling Price of Coal, by R. A. Colter 412
Western Kentucky Coal Mining, by Newell G. Alford 414
Auckland Park Colliery Explosion, by James Ashworth 416
The Briquet for Saving Fuel Waste, by Day Allen Willey 418
Why Technical Editors Seek Euthanasia 420
Hisylvania Mine, No. 23, by Wilbur Greeley Burroughs 421
Mining Exhibit at Panama Exposition 424
Weathering of Coal 424
Notes on Haulage Clips, by W. G. Salt and A. L. Lovatt 425
Rules for Prevention of Accidents, by James E. Roderick 429
To Prevent Mine Doors Being Left Open, by Simon H. Ash 431
Book Reviews 432
Mining at Lowe West Virginia, by William Z. Price 433
Analyses of Mine Explosions 435
The Advantages of Machine Mining, by A. J. Moorshead 435
Taxation of Coal Lands, by R. V. Norris 437
D. L. & W. Coal Mining Department 439
The Annual Safety Boosting Banquet 440
Acton, Alabama, Explosion 440
The Letter Box—
Rope Lubrication—Information Wanted—Effect on Roof of Dewatering a Flooded Mine—Single-Motor vs. Two-Motor Types of Mine Locomotives—Pillar Drawing—Fiber or Paper Air Pipes—Land and the Common Law—Haulage Problem 441
Prize Contest 444
Obituary—
William Stein—John Skeath 448
Notes on Mines and Mining 446
Examinations—
Questions Asked at Examination for Underground Managers, Nova Scotia, 1913 448
Mine Ventilation 452
International Engineering Contest 453
New Mining Machinery—
Portable Substation for a Coal Mine—A New Room Hoist—The Improved Hirsch Electric Mine Lamp—Safety Powder Cans—Belgian Tests of Hailwood Lamps—A Kerosene Blow-Pipe—Welch Hoisting Engine Controller—Large Electric Hoist—Williams Mine Stretcher 454
Trade Notices 457
Safety Calendars 458
Catalogs Received 458
What Next? 458
Squibs—
Pennsylvania, 1912, Coke Production, 407—Canadian Mining Institute Meeting, 408—The New Journal, 408—Thurmond Coal and Coke in 1913—West Virginia Coal, 432—Educated Fingers 436

A MOVEMENT is under way looking to the formation of a Local Section of the American Institute of Mining Engineers, to embrace members residing in the Anthracite Coal Fields of Pennsylvania. Local sections have been successfully established in other parts of the country, which have been of interest and value to the members connected with them. The American Institute of Mining Engineers was born in the anthracite region, and it is fitting that its birthplace should be the home of a strong and influential local section. A committee of members of the Institute is being organized to carry on the preliminary work of interesting other members in the formation of the Section.

The Prevention of Coal-Dust Explosions

CERTAIN coal dusts are explosive. That fact is settled. How effectually to prevent coal-dust explosions has not been exactly determined. Various preventive measures are in use in the bituminous coal fields of the United States, Great Britain, France, Belgium, Germany, and Austria. They are measures devised by the best mining authorities of each country. Beginning with this issue THE COLLIERY ENGINEER will each month contain an illustrated article descriptive of the preventive measures used in each of the countries mentioned. These articles have been specially written for our columns. They are not technical articles on the chemical combinations in the dusts that make them explosive. They are practical descriptions of preventives.

Naturally, there will be, in some instances, descriptions of similar methods, and these will be of value, because it will be evidence that such methods have been indorsed by competent men in different countries, and for that reason they are worthy of special consideration. The article in this issue describes French preventives, and was written by Pol Dunaime, an able mining engineer, who has been an investigator of mine explosions for the French Government.

Tests of Bering River Coal Unfavorable

COAL from the Bering River fields of Alaska was tested on the United States cruiser "Maryland" and found unsuitable for naval requirements. Compared with Pocahontas coal its efficiency was 71 per cent., and it was impossible to keep up a cruising speed of 15 knots with it for 24 hours.

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

Rear-Admiral Griffin said that "chemical tests led the naval officials to believe that there was a great future for coal from the Bering River fields, but actual tests show it does not come up to naval requirements." We are under the impression that the navy officials did not read the article in Vol. 31, Mines and Minerals, now The Colliery Engineer, in which Mr. George Watkin Evans noted that all black in Alaska was not coal. Doctor Crane, in recent unbiased articles in The Colliery Engineer, has demonstrated to experienced coal men that the quality of Bering River coal must necessarily vary and that its cost of production will be difficult to estimate. The Bureau of Mines is bringing out 900 tons from the Matanuska field and Rear-Admiral Griffin says "if this coal disappoints us, we will have to give up the idea of using Alaskan coal altogether." Where coal changes from soft to hard in short distances the results under boilers cannot be expected to be as satisfactory as when all soft or all hard coal is the fuel.

Roof Support

In A recent report on mining conditions under a section of the western part of the city of Scranton, made by Chas. Enzian, mining engineer, United States Bureau of Mines; H. D. Johnson, mining engineer; and D. T. Williams, a former State Mine Inspector, some valuable information on roof support is given. The report states that from the observation of the gentlemen named, in the Oxford mine, and in other mines, and from tests made by the United States Bureau of Mines for the Anthracite Mine Cave Commission, they arrived at the following conclusions as to the relative effectiveness of cogs and circular pillars constructed of mine rock:

"The universal method of building cogs consisted of timbers laid up in log-house manner, and filling the interior spaces with mine rock and refuse. Such cogs have been considered a very effective type of roof support, and are almost universally used for checking or arresting squeezes. We found, however, that circular pillars, built of mine rock, are far superior in effectiveness and supporting value, as indicated by tests that have been made. These circular pillars sustain in the neighborhood of 100 per cent. greater loads than the timber rock-filled cogs for the same per cent. of compression, and about 1,000 per cent. greater loads than timber cogs not filled with rock. Additional advantages possessed by the circular rock pillars, are: permanency and greater life, the low material cost of construction, and the plentiful supply of the necessary material.

"The relation of the diameter of these circular pillars to their height should be about $1\frac{1}{4}$ to 1. In other words the diameter should be about one and a quarter times the height."

During the time covered by the investigations made in the Oxford mine, a number of these circular rock pillars were constructed. They were located at points where the seam was 11 feet thick, necessitating pillars 15 feet in diameter. They were constructed at an approximate cost of $1.25 per cubic yard for labor. The rock used was taken from surrounding caved areas and local falls of top.

Strikes in Violation of Contracts

A RECENT decision of the United States Supreme Court holds that labor organizations, such as the United Mine Workers, can be held liable for damages resulting from the closing down of a mine due to a breach of contract made between the mine operator and the organization.

At a meeting of the Association of Bituminous Coal Operators of Central Pennsylvania, held early in January, the matter of troublesome strikes in violation of the contract between the Association and the United Mine Workers, was thoroughly discussed. Many members favored the dissolution of the Association and the abrogation of the contract in that way. Such a course was only defeated by a narrow margin.

A committee was then appointed to list all strikes that occurred in violation of the contract, and to ascertain from each operator the damages suffered by reason thereof; and to make a report within 30 days of the results of such investigation, together with such recommendations as the committee deemed proper toward instituting actions for the recovery of damages.

If the operators of Central Pennsylvania succeed in stopping troublesome local strikes in violation of the contract, by suing for and recovering damages, the national officials of the United Mine Workers will probably awaken to the necessity of disciplining their local subordinate officials who order or encourage such strikes in the anthracite regions and in other bituminous fields, as well as Central Pennsylvania.

Proposed Mining Legislation in Ohio

THE coal operators of Ohio are up against a serious situation. Owing to certain existing conditions in the bituminous coal business, natural conditions peculiar to Ohio coal fields, and other factors beyond the control of the operators, their "lot is not a happy one." The margin of profit on the output of their mines in 1912 was only about 2 per cent. on the capital invested. Indications are that when all the figures are obtainable the profits for 1913 will be shown approximately the same.

The greatest single item of cost in Ohio coal mining, as in all other fields, is the labor cost per ton of coal produced.

Under the contract now about expiring, Ohio miners are paid $1 per ton for *screened* coal passed over $1\frac{1}{4}$-inch openings. This is the same rate as that paid in Pennsylvania. In Illinois the rate paid is 61 cents per ton for

"run-of-mine" coal, and in Indiana the rate is $1 for screened coal or 61 cents for "run of mine."

The basis used to arrive at the screened coal rate in Ohio, was the relative proportions of screened coal and slack produced in the Hocking field. In that field the average results of mining showed 72 per cent. of screened coal and 28 per cent. of slack.

A simple calculation shows that 61 cents per ton for "run-of-mine" coal amounts to .0305 cent per pound. If $1 per ton is paid for screened coal, and the proportion of screened coal to slack is as 72 to 28, the miner must cut 2,778 pounds of "run-of-mine" coal to earn a dollar, and this is at the rate of .036 cent per pound. That is, the Ohio miner gets .0055 cent per pound, or nearly 15 per cent. more than the Illinois or Indiana miner who is paid 61 cents per ton for "run of mine." If the Ohio miner was paid the same rate per pound for 2,000 pounds of "run of mine," he would receive 72 cents, as against the Indiana and Illinois price of 61 cents.

Naturally, in the negotiations for the new contract, the Ohio miners will object to a reduction that will put them on the 61-cent plane, or on any plane below 72 cents.

To one not familiar with bituminous coal mining, the proposed change looks as if it would be advantageous to the operators if their men were paid at the rate of 61 cents per ton for "run of mine," but such is not the case. It would be decidedly advantageous, if all the available mine labor consisted of skilled miners, and they would use their skill in producing the largest possible proportion of lump. But the present available mine labor in Ohio is the same as in other states. A large proportion of the mine workers are illiterate, non-English speaking men, who have never thoroughly learned their trades as coal miners. These men usually produce more slack than skilled miners. Again, even skilled miners, if their remuneration does not depend on doing their work skilfully, will get careless, and the result will be a greater proportion of slack.

Some of the arguments offered by the Ohio Coal Mining Commission in its report to Governor Cox are very specious and would lead one who has not given the matter study, to believe that the present method of pay is iniquitous, but a careful analysis of the report, by one familiar with mining, will show their weak points.

The operators of Ohio are practically unanimous in their opposition to the proposed act. If it is made law, it will mean the closing of some mines at least, and possibly a considerable number, as it will be impossible to work them except at a loss. This will mean a serious blow to the state, and will limit the employment of mine workers.

As a matter of conservation, the idea is radically wrong. True conservation depends on the production of a natural resource in such shape as to secure for utilization the largest possible proportion in the most valuable marketable shape.

The greater the proportion of lump coal secured in mining the Ohio coal, the better it will be for the state and all engaged in the mining industry.

The operators of the state are practically unanimous in their opposition to the bill, and claim that its enactment will result in their trade being taken from them by competitive fields working under more advantageous natural and business conditions.

This provision of the proposed act requiring payment of mine workers on the "run-of-mine" basis is not the only mischievous legislation proposed. The proposition of placing in the hands of the Industrial Commission of the state the power to dictate the system of mining to be employed in Ohio mines, is one that cannot be too severely condemned. No mine owner in Ohio or any other state is going to use a dangerous or wasteful system of mining, if there is a safe and more economical system applicable to his mine.

A state commission is bound to be more or less of a partisan political body. It would have in its power the making of favorites and the breaking of those whom it does not favor.

Rational mine laws looking to the conservation of the lives and health of mine employes are all right. Such laws even if not perfect, are at present in force in Ohio. They can be perfected without destroying an important industry, and their enforcement can be secured through the State Mine Inspectors. Local conditions govern the systems of mining. To substitute the opinion of a commission at Columbus for the facts shown by local conditions prevailing at the mine, is the height of absurdity. The idea is a socialistic one evidently put forth for political purposes.

Another proposed bill, submitted by the Mining Commission, provides for safety foremen, and other apparently beneficial measures, some of which are not only burdensome, but which, by dividing authority, would destroy discipline, and increase dangers. Every intelligent mine worker, mine official, and mine inspector in the United States will agree that the greatest cause of mine accidents is lack of discipline.

Another proposed bill prohibits shooting off the solid unless the Industrial Commission issues a permit allowing it. The bill would mean something and would be a distinct forward step in increasing safety and rational conservation if it absolutely prohibited shooting from the solid.

Another bill providing for emergency supplies at mines is partly good, but its good features are nullified by its provisions being regulated by the Industrial Commission.

Taken all in all, it looks to an outsider as if the commission considered that its sole duty was to pave the way for the creation of berths for political favorites, and in doing so to cater to the socialistic ideas of some voters, and to hoodwink others who will not, or cannot, analyze the proposed bills and thus see how detrimental they are to both coal mine operators and coal mine workers.

PERSONALS

Thomas Prosser, superintendent of the Card & Prosser coal mines, near Youngstown, Ohio, has resigned his position and Thomas Morrison, of Dell Roy, Ohio, has been appointed to succeed him. Mr. Prosser's resignation is due to ill health.

T. J. Robson, who for several years past has been chief clerk in the office of the Department of Mines, at Charleston, W. Va., has resigned to become associated with the Wyatt Coal Co. He will be succeeded as chief clerk by Mr. W. L. Thomas, formerly with the Plymouth Coal Co., Plymouth, W. Va.

David T. Evans, secretary of the Kanawha Coal Operators' Association, has removed from Powelton, W. Va., to Cincinnati, with his family, and will open an office on the 15th floor of the First National Bank building.

A. O. Goedecke, for 28 years general outside superintendent for G. B. Markle Co., at Jeddo, Pa., left the service of the company in December last.

George Hartshorne, formerly fire boss for the Atlantic Coal Co., of Boswell, Pa., has been promoted to the position of mine foreman, while George Watson, formerly fire boss in the same mine, has been promoted to position of assistant mine foreman.

Hywel Davies, of Lexington, Ky., president of the Kentucky Mine Owners' Association, has resigned as a member of the board of trustees of the Kentucky State University.

Elmer O. Long has tendered his resignation as assistant chief engineer of the Consolidation Coal Co., at Somerset, Pa., to engage in engineering partnership with Frank B. Fluck. The new concern will be known as Fluck & Long, with offices in Somerset.

Greyson P. Troutman, division superintendent of the Lackawanna Division of the Lehigh Valley Coal Co., at Pittston, Pa., resigned on the first of the year to become assistant general manager of the Markle & Co. operations at Jeddo, Pa. Mr. Troutman is succeeded at Pittston by Harry H. Otto, of Wilkes-Barre.

Samuel B. Eaton, general superintendent for Crear, Clinch & Co., near Duquoin, Ill., has resigned his position with that corporation. He will be succeeded by E. C. Searls.

M. T. Davis, president of the Cabin Creek Consolidated Coal Co., has retired. William Puckett has been elected president. The Davis interests have been purchased by Mr. Puckett and other large stockholders in the company.

W. J. Brown, once outside foreman at Phoenix Park colliery of the Philadelphia & Reading Coal and Iron Co., has been appointed outside superintendent for that company's collieries in the Ashland district, near Minersville, succeeding William A. Sauerbrey, resigned.

F. A. Hill, former manager of the Wilkeson Coal and Coke Co., of Washington, has been succeeded by Joseph Lee, who was superintendent.

L. W. Davies, for many years superintendent of the Carbon Hill Coal Co., at Carbonado, Wash., has resigned to accept the management of the new coal mine in the Green River district of King County, Wash.

J. F. Menzies, formerly superintendent of mines for the Northwest Improvement Co., with headquarters at Roslyn, Wash., has moved to Carbonado to take the position left vacant by L. W. Davies.

George Bayne has been succeeded by G. W. Manley as manager of the Carbon Coal and Clay Co., at Bayne, King County, Wash.

F. W. Lukins, once with the O'Gara Coal Co., is general manager of the Waverly Brick and Coal Co., with headquarters in Kansas City, Mo.

Thomas M. Jenkins, St. Louis, Mo., has been appointed general manager for the St. Louis & O'Fallon Coal Co. The mines of the company are located in the vicinity of O'Fallon, Ill.

The recently appointed mine inspectors examining board of the southern anthracite region of Pennsylvania, consists of John H. Pollard, division superintendent of the Philadelphia & Reading Coal and Iron Co., at Mahanoy City; George Keiser, superintendent of the Pine Hill Coal Co., at Minersville; together with W. A. Mengle, of Shamokin, D. J. Davis, of Pottsville, and P. Orme, of St. Clair, all miners.

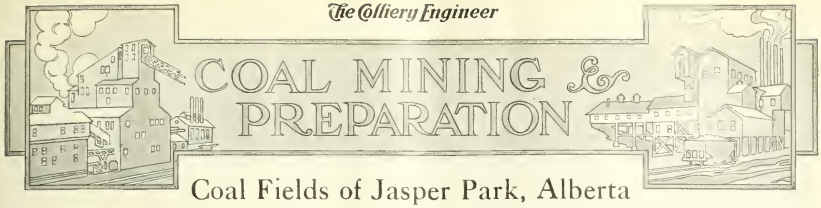
Clarence R. Claghorn has resigned as general manager of the Northwestern Improvement Co., and C. C. Anderson, who was general superintendent for the same company at Red Lodge, Mont., has been appointed his successor. It is reported that there is a probability of the general offices of the company being moved from Tacoma to Roslyn, Wash.

Malcolm Macfarlane has been appointed Inspector of Mines for the New York Central & Hudson River Railroad, with headquarters at Philipsburg, Pa., vice H. B. Douglas, assigned to other duties.

David C. Botting, for 8 years Inspector of Coal Mines for Washington, recently accepted the position as Commissioner for the Mine Operators of Washington. Mr. Botting recently returned from the Matanuska coal field of Alaska, where he went to superintend the mining of the 900-ton sample for the United States Navy Expedition, which expedition was under the direction of Geo. Watkin Evans, of Seattle.

Clarence Hall, who for a number of years has been expert in charge of the Explosives Section of the United States Geological Survey, and afterwards the Bureau of Mines, has opened an industrial laboratory in Pittsburg, Pa., where he will test supplies and give advice on patents pertaining to the explosives industry.

At the thirty-first annual meeting of the Colorado Scientific Society, in December, 1913, the following officers were elected to serve during 1914: President, Richard A. Parker; first vice-president, E. N. Hawkins; second vice-president, Thomas B. Stearns; treasurer, J. W. Richards; secretary, H. C. Parmelee. Executive committee, term expires January 1, 1917, J. D. Skinner, Charles A. Chase. Executive committee, to fill vacancy expiring January 1, 1916, Victor G. Hills.



Coal Fields of Jasper Park, Alberta

A Description of Some Canadian Fields Containing Bituminous Coal That Will Soon Be Developed

By Frank E. O'Neal

JASPER PARK district is situated in the western part of Central Alberta, at the entrance to the Yellowhead Pass, and is of considerable importance on account of its extensive coal deposits.

The Athabasca River flows diagonally across the trend of the mountains, and occupies a wide sediment-filled valley, affording an easy route for the railroads building westward.

FIG. 1. CONGLOMERATE AT BASE OF PRODUCTIVE COAL MEASURES

The Grand Trunk Pacific is nearing completion, and is at the present time running trains to Mile 142, B.C. The division of the Canadian Northern from Edmonton to the mountains is being rushed, and should soon be in condition for traffic. These railroads open up the coal areas on both sides of the river and afford excellent shipping facilities. As the coals of the district are all coking, considerable coke, will, with the completion of the railroads be shipped into British Columbia. One company, the Jasper Park Collieries, Ltd., Fig. 3, has been shipping coal for some time from its mine at Pocahontas, and is at present developing property on the north side of the river. Eastwards in the foot-hill belt two different companies are developing their holdings, and will soon be producing coal.

The district was originally well forested throughout, except on the higher peaks and ridges. In late years fires have killed the greater part of the large timber, so that now only a few isolated areas remain. A considerable part of the fire-killed timber remains standing and decays very slowly. In the vicinity of the mines this timber is used for temporary structures and mining purposes. The remaining forests are usually dense and contain considerable undergrowth. Pine and spruce are the most common of the conifers while the broad leaf class is represented by the birch and poplar.

The topography in general is that of a rugged mountain region, bounded on the east by low, irregular foothills, as from a plain. The valley of trend of northwest and southeast, and when seen from a distance appear to rise abruptly from the foothills as from a plain. The valley of the Athabasca varies in width up to 2 miles, and contains many backwater channels and small swamps, as shown in Figs. 4 and 6. The tributary streams in the mountains are confined to transverse valleys; they are swift flowing and move a large amount of gravel into the valley bottom, thus forming obstructions and damming back the river. The highest peaks seldom exceed 8,000 feet, as in the case of Roché Miette in Fig. 5, and as the river valley has an elevation of 3,200 feet, the difference in relief is not very often over 4,800 feet. Eastwards in the foot-hills at the outlet of Brule Lake, a barrier consisting of a succession of Cretaceous sandstones forms a series of rapids with a uniform gradient. That this barrier has been lowered is shown by terraces of lake deposits, Fig. 7, in places 100 feet above the present water level.

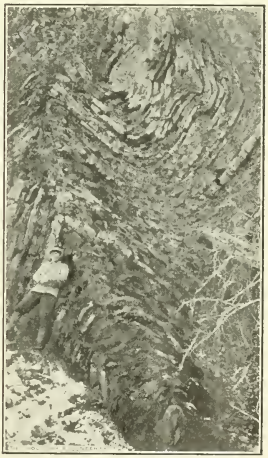


FIG. 2. CRUMPLING IN THE COAL MEASURES, MOUNTAIN BASIN

The rocks of the district are all

sedimentary in origin from the Cambrian to Cretaceous times. The compression necessary to form the mountains was relieved along the eastern border by faulting, so that now thick blocks of Paleozoic strata are found overthrust upon younger Mezozoic strata. At the upper end of Brule Lake, Devonian limestone overlaps upon the Kootanie coal measures for a distance of over a mile. These fault planes have steeper dips in the western than in the eastern part of the district, but they differ very little in angle from the dip of the strata. The younger Mezozoic rocks that form the foot-hills are owing to their composition more likely to crumble than to fault sharply when subject to pressure, and consequently the faults that do occur have small throws and do not reveal themselves as those of the mountains. Within the transverse valleys of the mountains the Kootanie formation marks the summit of the consolidated beds. In the foot-hills, however, the Kootanie is overlain conformably by several thousand feet of later Cretaceous strata, and it is only along the eastern border of the first range that the uplift has been sufficient to expose these once deeply buried rocks.

The Paleozoic rocks consist principally of massive limestones, with some thin sandy limestones and argillites at the bottom. They form the mountain ranges and are well exposed, but have not been studied in detail and no attempt has been made to ascertain their total thickness. Immediately above the Carboniferous limestones is a series of reddish shales and dolomites overlying some brown shales and quartzites. These beds have been classed as Triassic and Permian from their position and likeness to known beds in the south.

The Fernie shales consist of dark fissile shales with a few arenaceous bands that contain marine shale. Toward the bottom are found pockets that contain dark chert gravel.

Cretaceous. Kootanie Coal Measures.—This formation is of the greatest commercial importance, containing as it does all the coal exploited in the district. The measures consist of dark shales, silicious sandstones, coal seams, and one conglomerate, shown in Fig. 1. The pebbles of this conglomerate consist of chert and are sometimes green and gray, though dark blue ones generally predominate. The cement is silicious and the pebbles well sorted as to sizes. Unlike the other formations in the district the strata of the coal measures show an entire want of regularity, the beds differing in thickness and character in places situated at short distances from one another. The repetition and similarity of different beds, as though from the recurrence of practically the same condition of sedimentation, makes it impossible to recognize the different horizons of the measures and adds greatly to the difficulties encountered in tracing the coal seams. The only horizon mark that is continuous is the massive, hard, silicious conglomerate near the center of the formation. This conglomerate has been used by Mr. D. B. Dowling* as a divisional line in dividing the Kootanie formation, into the Upper Productive and the Lower Barren Measures. The stratigraphic irregularity may have been caused partly by the action of contemporaneous erosion. The conglomerate

Stratigraphy	*Lithology*
Recent	River Deposits.
Pleistocene	Boulder clays; cemented gravel.
Cretaceous	In the disturbed area of the foot-hills the Cretaceous is complete. In the mountains only the lower of the Kootanie formation is present.
Jurassic	Dark fissile shales and sandstones.
Triassic	Red and yellow shales and sandstones.
Permian	Dolomites, quartzites.
Carboniferous	Thick beds of limestones and shales.
Devonian	Heavy bedded limestones.
Silurian	Shaly limestones.
Cambrian	Yellow sandy limestones and red argillites.

Fig. 3. Tipple, Jasper Park Collieries Co.

Fig. 4. First Range of Rocky Mts., Athabasca River in Foreground

Fig. 5. Summit Roché Mietto

* G. S. C. Summary Report, 1911.

in the eastern part of the mountain basin changes abruptly to a fine-grained sandstone; when traced northwards it again resumes its former condition. It is probable that this conglomerate was partly removed when still in an unconsolidated state, and replaced by sand. consists of a variety of mica schists only known to occur in place in British Columbia at a distance of 50 miles. Other varieties are known to occur at varying distances on the west. This would point to an extensive easterly movement of the ice sheets.

wards the measures are known to extend back from the river for a distance of 10 miles and probably connect with some of the basins south of the Smoky River. In the center of the valley the coal measures are in the form of a shallow syncline in which only lower seams

Fig. 6. Second Range Rocky Mts. Black Line Shows Fault Plane

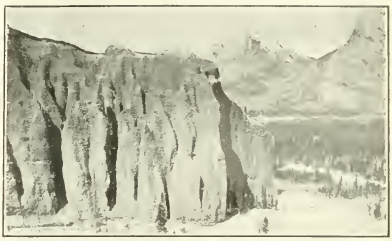


Fig. 7. Pleistocene Cemented Gravels. Athabasca River on the Right

Conditions similar to this have been found in the Big Horn coal basin† about 70 miles to the south. The irregularity of the measures is shown by the following sections:

Section Northern Portion of Mountain Field, Descending Order	Feet
Shale	200
Sandstones	250
Coal	6
Shales	90
Coal	6
Shales, sandstones	100
Coal	7
Shales	75
Coal	15
Sandstones and concealed conglomerate	150

These measures are the general width of the seams between the walls and include all partings.

Section Southern Portion, Descending Order	Feet
Sandstones	60
Coal	11
Sandstones and shale	250
Coal	10
Sandstones	350
Coal	5
Sandstones	2
Coal	3
Sandstones and shales	300
Conglomerate	

A large portion of the valley bottoms are buried by a heavy mantle of drift, that in places has been trenched by streams to a depth of over 300 feet before exposing bed rock. When exposed in clefts these deposits are found to consist of gravel well sorted as to size near the base, but without any arrangement in the upper portion. A large portion of this drift consists of rocks foreign to this district; one class

† G. S. C. Memoir No. 9 E., by G. S. Mallock.

Coal Fields, Foot-Hill Area.—In advance of the First range, the Kootanie coal measures are exposed in the form of a long anticline. This anticline reached its maximum uplift in the vicinity of the Athabasca River, where the denuded end shows a central axis of limestone, and was given the name of Folding Mountain by Mr. James McEvoy*. A large portion of the eastern limit is available as a mining area, but the western limb is very much broken and crumpled and partly overridden by Devonian limestones. The anticline is hard to follow northwards, since in the river valley erosion has been heavy and the strata are concealed by drift. North of Brule Lake a probable continuation of this anticline exposes the coal measures, the western portion, as on the south side of the river, dipping beneath the limestones.

Mountain Basin.—Within the first range of the mountains remnants of the coal bearing beds are found both in the center of the valley and in contact with the fault block on the west. Owing to an uplift and erosion, the productive measures do not extend over 8 miles from the river. North-

* G. S. C. Yellow Head Pass route, by James McEvoy, 1898.

are present. The western portion is a monoclinal block, with a dip to the southwest of from 50 to 70 degrees. On the north side of the river this block is modified by the introduction of a second fold on the west. Along the western edge Paleozoic limestones are overthrust upon the measures and at the contact the beds are folded back and crumpled. The rocks of this block are less disturbed than those of the syncline on the east, and offer the more favorable conditions for mining.

As has been stated, owing to the variation of the strata along the strike, it has been practically impossible to correlate seams in different parts of the field. General experience in other fields where the Kootanie formation has been worked has shown that the coal seams are more regular than the intervening strata. The Kootanie coal beds now worked, except in rare instances, have been found to be continuous unless cut off by faulting or crumples. It is rather the exception than the rule to find coal seams exposed naturally on the surface; and as a complete section has not been exposed by prospecting, it is impossible to state the exact number of seams present. However, the

prospecting done has proved a number of seams of workable size, and in the mountain basin where the greatest amount of work has been done, a total of 40 feet of workable coal has been found.

The Kootanie formation is less disturbed in the foot-hills than in the mountain basin, consequently the coal will be found in better shape, although not so high in fixed carbon.

Coal Breaker at Whitwick Colliery

A coal breaker which was erected in July, 1910, at the Whitwick colliery, in Leicestershire, was the forerunner of a good many similar plants which have given evidence of satisfactory work in Great Britain. The designers had in view the breaking of large coal to any desired size by various easy adjustments of

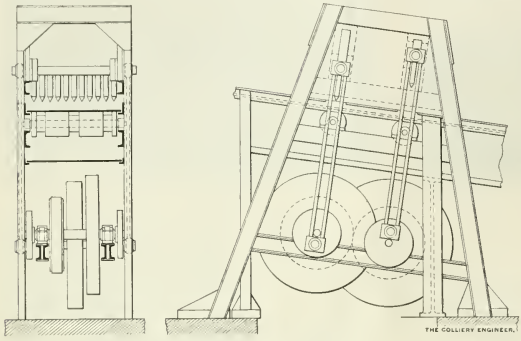


Fig. 1. New Form of Coal Breaker

Within the mountains, crumples and slips, as shown in Fig. 2, have been noted and some of the coal is fine and flaky, evidently having been badly crushed. In some parts the strata are less disturbed than in others, and mining at present is confined to these areas.

The coal seams are found very often to be resting upon sandstones, without any fossil roots, so that it is probable that the vegetable matter to which the coal owes its origin, was accumulated in the form of peat bogs.

A large part of the coal is soft and will not stand handling without crushing. This, however, is not a great detriment, for when used for steaming, it cokes as soon as put into the furnace, and consequently little is lost through the grates. All the coal so far as known will coke, and where it has been used for steaming, is said to have compared favorably with that of the Crows Nest Pass mines.

mechanical picks, without the formation of any more slack than is made by hand breaking, together with the possibility of attaching the machine to most existing picking belts without any structural alteration to them. The first machine not only did the work of six men that were on the belts picking with picks, but it worked in a very efficient and uniform manner. It is found that coal which has passed under the machine is more evenly distributed on the elevating belt, enabling the screens to deal in a better manner with the flow of coal; that the coal is made more uniform in size, and that where it is necessary to employ labor in breaking, a large sum is saved in wages which is calculated to cover the cost of installation in a few months. The arrangement is shown in Fig. 1, in the side and end elevation, the belt being 4 feet wide, and the apparatus being able to deal with 200 tons per hour. The breaker consists of a set of mechanically operated picks working upon the coal as it passes along the picking belt, the two sets of picks being arranged in tandem and operated through eccentrics giving varying strokes of 12-inch, 14-inch, and 16-inch thrust, so that various sizes of coal can be made. It is easily possible to set the picks at greater or less distances apart, and when it is not required to break the coal, the picks can quickly be thrown out of action. Cast-iron rollers are housed on the framing at the point of breaking in order to support the links and plates of the picking belt. The second-motion shaft is driven from the first shaft through gear-wheels, belt driving being adopted on the first shaft. In the Whitwick colliery, the top of the belt runs level with the top of the railway truck, the various qualities of coal being picked out into the trucks and the remainder passed on to the screen by inclining the picking belt. In order to accomplish this, the driving gear is placed under an inclined portion of the picking belt. The first set of picks acts as a species of spreader for the second set, the latter dealing with the lumps which pass the operation of the first set. The belt is driven by an 8-horsepower electric motor.

The Old Freibergers in America

The regular annual meeting of the Old Freibergers in America, took place at the Hofbrau Haus, Broadway and 30th St., New York City, on December 20. A very pleasant evening was spent around the festive board. All the former officers were reelected; namely, Dr. R. W. Raymond, president; Gardner F. Williams, vice-president; and C. L. Bryden, secretary and treasurer.

It was decided to hold a meeting in San Francisco in 1915, during the Panama Pacific Exposition, and a number of the members are planning to go to Freiberg in 1916, to help celebrate the 150th anniversary of the founding of the old Bergakademie.

French Coal Dust Precautions

Methods Employed to Avoid Ignition of Dust and to Stop the Propagation of Explosions if Started—Spraying—Use of Water and Stone Dust Barriers

By Pol Dunaime*

To guard against dust explosions, precautions must be taken to prevent their starting and further precautions to prevent their continuing when once started.

To prevent an explosion starting it is necessary to eliminate all possible chances that might lead to an initial inflammation, and further to render the dust non-inflammable.

The most probable initial causes of a dust explosion are the ignition of firedamp, improperly tamped shots, or defective working conditions, especially, if safety explosives are not used.

All means taken to prevent the ignition of firedamp, reduce the dangers from dust; and in the dusty coal mines safety explosives should be used exclusively. The use of this kind of explosive and, above all, the good condition of the tamping are the most essential and the most efficient measures to be taken against coal dust exploding.

Another source of danger, which although much less important, must not be ignored, is the fact that very dense clouds of inflammable dust take fire when coming in contact with a flame or an electric arc. It will, therefore, be necessary to avoid the possible existence of unprotected flames or electric arcs at the points where a very dense cloud of inflammable dust can be formed, especially near the coal chutes, at the bottom of the inclined planes, or near the rotary dumps, when the coal is dusty.

The two principal means adopted to render coal dust non-inflammable are sprinkling with water and schistification, or stone dust treatment.

Sprinkling.—A sufficient and careful sprinkling, repeated often enough, may give good results. In order to produce conditions unfavorable to the formation of a dust explosion, it is necessary that the dust be brought to a muddy state, or, in case the dust is not mixed with a sufficient amount of water, that, at least, it comes in contact with a weight of free water equal, as a minimum, to its own weight; the dry dust of the enclosure is still dangerous even if the floor is abundantly sprinkled. To regulate the intensity and the frequency of the sprinkling in a group of working faces or entries, the weight of the dust is calculated per meter, by means of a previous removal from determined lengths on the ground and on the walls, everything that passes through a sieve provided with round holes of 2 millimeters in diameter being considered as dust; experiments are made to show the speed of evaporation, and everything is prepared so that the above-mentioned conditions (referring to the muddy state or to the necessary weight of the free water) are realized at any time, even at the period immediately preceding the repetition of the sprinkling. The quantity of water must be considerably increased, if in the same working face several blasts are fired at the same time, or successively, without repeating the sprinkling after each blast. To perform the sprinkling of the working faces in which the quantity of dust is small, the Anzin Mining Co. has experimented with the water sprayer shown in Fig. 1.

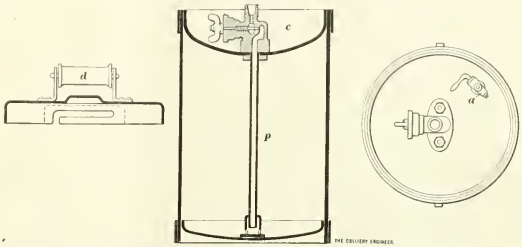


Fig. 1. Water Sprayer

This portable sprayer consists essentially of a cylinder tested to 14 kilograms pressure and provided on its upper part with a cock *c* for the introduction of the air and the water into the cylinder, and an air cock *a* for letting out the air while filling the vessel with water. The pipe *p* that extends nearly to the bottom of the vessel may be closed by means of the cock *c*, and it is possible to screw on this cock, when desired, by means of a screw cap, rubber tubes, one for introducing compressed air, and the other terminating in a nozzle which constitutes the sprinkling tube.

On the upper part of the cylinder a special cover is fixed by a sleeve coupling, for the purpose of preventing cocks *c* and *a* from being damaged. It is provided with the handle *d* for convenience when carrying the apparatus.

This portable sprayer, when loaded contains 9 liters of water and 3 liters of compressed air at 5 kilograms pressure. In charging the apparatus, 9 liters of water are poured in from a gauged vessel through a funnel, while cock *a* is open. The sprayer is then connected with the compressed air pipe by means of a rubber tube and suitable pipe fittings; after which cock *a* is closed, the cock *c* and the cock of the air hole pipe are opened and the apparatus is loaded with 3 liters of compressed air. When this has been done, the sprayer is disconnected from the air pipe and is protected with its cover.

All the vessels are loaded during the day, a label pasted on each of

*Civil and Mining Engineer.

them indicating where it will be used. A hose for sprinkling placed in each working face is connected with the sprayer, after which all that it is necessary to do is to open the cock *c* and place the hose in the proper position to sprinkle a distance of 15 meters in the direction of the blast.

In many dusty mines, this water sprinkling would be altogether inadequate; therefore, those mines have adopted a sprinkling system in which water is piped to the working places. This is the only method that furnishes a really abundant quantity of water, and which must be considered the best when using this process.

Stone Dust Treatment.—Stone dust treatment is not less efficacious than sprinkling, in the prevention of the formation of dust. It is not to be recommended at the working faces, because it soils the coal; but its use is very practical in the entries, provided it is continued to a certain degree. The stone dust in a fine state is applied by throwing it by hand, on the walls and floor of the entries. Most of the stone dust falls on the floor, where it may mix with the coal dust, but it is preferable to remove all the coal dust from the district before applying the stone dust.

It is known that coal dust mixed with other materials has different degrees of inflammability, characterized by a combustion more or less rapid, and corresponding to the following practical distinction; namely, in order to propagate an explosion in a dusty mixture, the initial explosion must be as much more violent as the mixture is less inflammable.

J. Taffanel in "Notes on the Classification of the Deposits of Dust,"* has given the characteristics of two of these degrees of inflammability called Limit 1 and Limit 2. Care should be taken, in a general way, to have the dust less inflammable than the limit 1, in coal mines in which there is no firedamp, and less than in limit 2 in mines containing firedamp.

*J. Taffanel, July, 1912, Publication of the Experimental Station of Liévin. From the same author: "L'Etat de la question des poussieres." October, 1912 ("The Condition of the Question of Dust," October, 1912).

In mining work, an engineer generally takes care of this control during the time necessary for the treatment, and trains an employe of the same class as the man in charge of the ventilation, who afterwards assumes the responsibility of this work.

In the entries where the dust is in small quantity, the controller for the dust makes quantitative experiments in order to determine the weight of fine dust per cubic meter in the entry; the name "fine dust" designates particles of coal or of

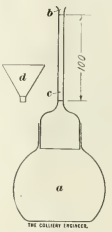


Fig. 2

schist passing through a No. 200 sieve with 4,900 holes per square centimeter. After having collected a sample of dust from a measured section of the entry, the dust obtained is weighed and the proportion which passes through the No. 200 sieve is determined, using for this purpose a part of the sample thoroughly mixed. These operations are performed generally in the mine, and a letter scale and a graduated glass tube are the only necessary instruments.

In the entries containing a comparatively large quantity of dust, and where the question of the fine particles is not important, but where the amount of ash characterizes the danger of the dust, the controller will make only qualitative experiments. The percentage of ash is determined by incineration, or by means of an apparatus called "Volumenometer" which is based on the following principle:

The dust on the floor is constituted principally of a mixture of particles of coal and particles of rock. The real density of the different kinds of coal is about constant; this is also true for the density of rocks of a definite bed, therefore, if it is admitted that the dust on the floor is a mixture of these two elements, its percentage in ash is a lineal function of the real density of this dust.

A simple means of determining this density consists in measuring the volume occupied by a determined weight of dust. From the density thus obtained, the percentage in coal is then deducted.

Volumenometer of the firm Poulenc Brothers is shown in Fig. 2. The vessel *a* has a capacity of about 50 cubic centimeters. The measuring tube is graduated from *b* to *c* and fits the mouth of vessel *a* like a ground glass stopper.

To examine the dust sample and ascertain the percentage of coal therein, 15 grams are run into the vessel *a* by means of the funnel *d*; 25 cubic centimeters of wood alcohol is next poured into the vessel and the tube stopper replaced. The mixture is then stirred, 25 cubic centimeters of alcohol poured through the tube and the number of the division on the tube corresponding with the level of the liquid noted.

For example, if stone dust has a specific gravity of 2.143 then 15 grams would occupy 7 cubic centimeters which would be the mark 57 on the scale. If, however, there was a mixture of stone and coal dust, say of a specific gravity of 1.75, it would occupy a space of 8.56 cubic centimeters and register 58.56 on the scale. The percentage of coal dust in the mixture would then be $2.143 - 1.750 = .393$ and $\frac{.393 \times 100}{2.143} = 18.3$ per cent.

This process is much more rapid and more convenient than the determination of the percentage of ash by means of calcination.

The engineers have thus a means of finding out periodically the degree of danger caused by dust in their works. They, therefore, know where to take the necessary precautions, and to what extent it is advisable to apply the stone dust treatment, to avoid any initial cause that might produce a general explosion of dust.

When an exact idea of the degree of inflammability of the natural dust is wanted, it is necessary to proceed to some experiments concerning the inflammability; for this purpose a comparatively simple apparatus, devised by the Experimental Station of Liévin, is used, called "Inflamer with oxygen and flame," of which a description may be found in the "Notes on the Classification of Deposits of Dust" previously mentioned.

Most of the French mining companies have organized a service for the control of the dust, and have applied in a general way the stone dust treatment, preceded by the removal of the coal dust. A gang is in charge of the main haul ways and inclined planes, that are treated in turn, according to an order that the man in charge of the work may change when necessary; and the cleaning of the working faces and the stone dust treatment or the claying applied to them is considered as a normal part of the work with an organized corps under the leadership of a responsible foreman.

As the material used for neutralization, ashes of the flues of the boilers can be recommended, the slag of the boilers is not so advisable, because it still contains fuel and its fragments being sometimes sharp, may produce bad effects on the respiratory organs.

At the mines of Albi, the clay gives good results. This clay without preparation, is spread on the floor by means of a shovel, as a thin layer more or less continuous and uniform, according to whether the complete stone dust treatment (at 100 per cent.) or, the partial treatment (at 50 per cent.) is to be applied. The clay is soon pulverized under the feet of men and horses and becomes an impalpable dust very convenient for the neutralization. As a general rule, the stone dust treatment immediately follows the removal of the coal dust; that is to say, after having cleaned the ground for a certain length (15 to 20 meters), the clay is spread on that surface.

The net cost of the stone dust treatment is variable according to the conditions of the operation. When the coal dust treatment is made on the whole floor, the price reaches about .8 cent per meter of entry.

The interval between two successive treatments generally exceeds 4 months. For instance, if the floor of an inclined plane, over which 150 tons of coal pass daily, has received the complete stone dust treatment at 100 per cent., it still retains 74 per cent. after 3 months.

According to Article 142 of the Mines Regulations of August 13, 1911, in all entries connecting two sections of the ventilating system or two groups of sections, in which the effective force of men does not exceed 150, "steps must be taken to prevent a dust explosion occurring in one of these sections from being communicated to the others."

In order to comply with this law two different arrangements have been adopted in French coal mines, one the stopping zones, and the other the stopping barriers. Each method may be operated in two ways according as to whether water or incombustible dust is used as means of stopping the flame. We shall therefore study successively:

The stopping zones by sprinkling.

The stopping zones by stone dust treatment.

The stopping barriers by water.

The stopping barriers by incombustible dust.

The length of stopping zones now recommended is 200 meters. The rates of sprinkling or stone dust treatment at present admitted are as follows:

When sprinkling is used the weight of water in the stopping zone must be at least equal to four times the weight of the dust.

For the stopping zones in which the stone dust treatment is applied, the proportion of incombustible material must be 90 per cent. of the mixture.

These zones, sprinkled or treated, obtain the maximum of efficiency in the entries where the explosions can be spread only slowly; namely, in the winding entries with a small section. In the straight entries with a large section, the zones must be longer. It will be well to bear in mind that the sprinkling and the stone dust treatment give good results only when applied in the proportions mentioned.

To practice an abundant sprinkling, it is almost always necessary to do it by means of pipes; in some special cases, pumps carried on flat cars can be used; the water is then brought by means of cars to the place where it is used. The frequency and the intensity of the sprinkling are dependent on the natural moisture in the mines, and on the ventilation; generally, a section to be kept in good order must be sprinkled once and often twice daily.

At the same time with the stone dust treatment, the liming of the walls may be used to advantage. Experiments proved after a two and a half months' trial that 90 per cent. of the stone dust remained in an entry treated with lime and the stone dust, through which 100 tons of coal and 75 tons of dirt passed daily, with a ventilating current of 7.3 cubic meters per second, at a speed of 1.066 meters. The expense connected with the liming and the stone dust treatment of a section of 100 meters is about 40 francs ($7.80).

The stopping zones treated with stone dust are more economical than those treated by sprinkling; they seem in fact to be preferred; for instance, the Anzin Mining Co. keeps 10 sections sprinkled, while it has 35 sections treated by lime and stone dust.

Stopping barriers are different from the sprinkling or the stone dust treatment and have given very favorable results at the experimental station of Liévin.

Stopping Barrier of Water.—On a length of about 20 meters, several boards are fixed transversely under the roof of the entry. A certain number of rotary tanks are placed on them, Fig. 3, containing 120 liters of water per square meter of the section of the entry. Each tank, shaped in the form of a gutter, rests on the horizontal board. To keep it in stable equilibrium, it is wedged, if necessary, by a few particles of sand,

so as to keep it upright under normal circumstances, but so it will be upset by any blast more violent than the normal air circulation. The open space above the board must be such that the tank can be placed and be rotated. The distance between the two board tank holders on an entry must be equal at least to two times the width of the tank, and the length of the latter must be only a little short of the width of the entry, not so long, however, as to run the risk that a shock or a contact against the lateral walls or the timber work would prevent its being upset.

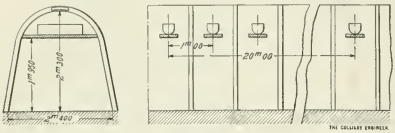


Fig. 3. Cross and Longitudinal Section of Water Barrier

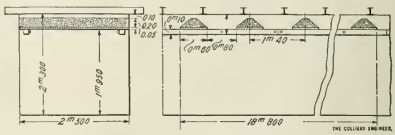


Fig. 4. Cross and Longitudinal Section of Dust Barrier

To compensate for the evaporation of water from the tanks, the water must be added periodically, in order to have the tanks always contain the quantity mentioned, and the capacity of the tanks will, therefore, be made large to avoid frequent filling.

Example:
Section of the entry, $S = 4.4$ square meters.
Total volume of the water, $V = S \times .120 = .528$ cubic meter.
Volume of water for each tank, .025 cubic meter.
Number of necessary tanks, $\frac{.528}{.025} = 21$.
Distance between the axes of two tanks, 1 meter.
Total length of the stopping barrier, 20 meters.

Stopping Barrier of Incombustible Dust.—For a length of about 10 to 20 meters, a total volume of incombustible dust, equal at least to 4 hectoliters (.4 cubic meter) per square meter of the section of the entry, is heaped on boards fixed transversely under the roof of the entry, Figs. 4 and 5. On each platform the heap occupies the whole width of the entry; its thickness does not exceed 25 centimeters; and the top of the heap is about 5 centimeters below the collar of the timber set, so that there will be sufficient space to permit the draft caused by the explosion to break and scatter the dust heap. In arched entries or those provided with a metallic frame, the heap is arranged in such a way as to present a surface for dislodgment, with open spaces measuring at least 5 centimeters, on a length equal to two-thirds of that of the shelf; there will be at least ten shelves, having at the most .6 meter width and with a space between them of at least .6 meter. The incombustible material, ashes, crushed schist, etc. will not be reduced to such a degree of fineness, that the regular ventilation currents could stir it. The largest sizes of the material used will not exceed 5 millimeters in diameter; and will be of such a nature that the particles do not agglomerate, and if such a tendency is observed, the material must be changed, but may be used for the stone dust treatment on both sides of the stopping barrier.

Example:
Section of the entry, $S = 2.5$ meters $\times 2.3$ meters $= 5.75$ square meters.
Total volume of incombustible dust, $V = S \times .4$ cubic meter $= 5.75 \times .4 = 2.3$ cubic meters.
Width of the boards, .6 meter.
Volume per board, $\frac{.6+.1}{2} \times 2.5$ meters $\times .200$ meter $= .175$ cubic meter.
Number of necessary boards, $\frac{2.3}{.175} = 13.2$; that is, 14 boards.
Distance between two boards, .8 meter.
Total length of the stopping barrier, $L = 14 \times .6$ meter $+ 13 \times .8$ meter $= 18.8$ meters.

In establishing stopping barriers it is not advisable to modify the course of the explosion by increasing the obstruction of the entry, because, if it is true that a strong obstruction slackens the progress of the explosion, it has, on the other hand, the disadvantage of interfering with the ventilation, and increases by this fact the risk of firedamp explosions and consequently of dust explosions. Moreover, if the slackening of the explosion by means of obstruction or sharp turnings in the entries increases very much the efficiency of the stopping zones, it does not seem to alter to a great extent the degree of efficiency of the stopping barriers.

The arrangement may vary, to conform with the dimensions of the entries. In the case of high entries, it is possible to superpose two stories of transverse shelves, always leaving between them an open space of at least 5 centimeters above each deposit.

In the case of large entries, one part of the incombustible deposit may be placed on lateral supporters fixed to the walls of the entries, Fig. 6; but this arrangement is less favorable for putting the dust in suspension than shelves across the entry, and also less favorable to the action of the dust on the flame during the period it is falling. This disadvantage is obviated by dividing the deposits into many heaps projecting in the direction of the force created by the explosion. Each heap must be at the most .5 meter in the direction of the length of the entry, .3 meter in the transverse direction, and .2 meter thick; a space of at least .15 meter must be provided between them; two successive heaps in the direction of the length of the entry must be separated by an open space of at least 1 meter.

Conclusions.—The stopping barriers in the form of heaps of ashes and accumulation of water, in the experimental entry of Liévin, have proved more efficient than the other methods used. They are easier to be applied than the other methods, and what is still more important, their control is especially easy; because they keep in good condition for a comparatively long time, and a simple glance is sufficient to satisfy one as to their condition. The stopping barrier of incombustible dust, being easier to make than the stopping barrier of water, was preferred by the mining companies.

The following table refers to the coal basin of the Pas-de-Calais, which has an annual output of about 20,000,000 tons of coal, or about half of the output of France. It illustrates the progress made in 1911 in preventing the explosion of coal dust, and shows the increasing use of stopping barriers of schist dust.

	End 1910	End 1911
Stopping barriers of ashes	769	1,395
Stopping barriers of water	119	40
Damp sections with permanent sprayers	66	56
Other damp sections	75	71
Sections where liming is used	397	125
Total number	1,426	1,687
Length of the roadways kept in condition, kilometers	1,840	1,925
Length of the roadways periodically sprinkled, kilometers	187	170
Length of the pipes for sprinkling, kilometers	173	206

The experiments, made with a view of stopping the explosions, are actively pushed, but these experiments must not cause people to forget that, above all, it is imperative to try to prevent the occurrence of a dust explosion. Even when an explosion is limited, it may produce very serious results; besides the difficulty of stopping an explosion, when it is started, is so great, that even the best devised precautions are always somewhat uncertain.

In 1912 Pennsylvania produced 27,372,018 tons of coke valued at $56,054,478. The previous record year was 1907, with 26,513,214 tons.

Coke-Oven Gas for Power Purposes

Written for The Colliery Engineer

In Europe attention has been paid to the utilization of power obtained from coke-oven gas. The old beehive oven is rapidly going out of existence, although in Great Britain there are still a large number in operation. In Germany, the beehive-oven plant has gone.

The modern alternative, the by-product oven, is divided into two general types, the waste-heat type and the regenerative type. In the former the 50 or 60 per cent. of heat over and above that necessary for carbonization is drawn off in the form of hot waste gas, which is usually used in connection with steam boilers close to the ovens. This, however, involves immediate use and as this is not always possible, there is in some cases loss of heat units. In the regenerative coke oven, where the air for the combustion of the coal is preheated, there is a surplus of gas over and above that required to heat the ovens, and this surplus can be used outside the coke-oven plant. As this amounts to 50 or 60 per cent. of the total gas evolved from the coal, it becomes an important product. A brake horsepower hour may be developed by a gas engine on about 21 cubic feet of coke-oven gas. The gas can be stored in a holder, and in some cases in Germany is transmitted over large areas. Further, as pointed out by J. S. Leese, in the *British Westinghouse Gazette*, by the use of an exhaust boiler with the gas engines fired during shut-down periods by live gas from the holder, enough steam can be raised to supply the needs of the by-product plant.

During recent years attention has been paid to the development of a gas engine suitable for use with coke-oven gas. Trouble relating to tar and naphthaline in the valves has been met by modern by-product recovery methods, preignition troubles have been overcome by the use of suitable compression pressures, and the multicylinder construction of the engine gets rid of the necessity for water-cooled piston rods and too large cylinders, and gives the advantages of minimum floor space and foundation costs, good lubrication, high shaft speed, and low initial cost of engine.

An installation, for particulars of which we are indebted to the British Westinghouse Co., is to be found at Grassmoor, near Chesterfield, England, where the Grassmoor Colliery Co., Ltd., constructed 60 Otto by-product waste-heat ovens in 1906-7, together with the necessary condensing plant, etc., for the recovery of the sulphate of ammonia, tar, and benzol.

These ovens are capable of dealing with 2,000 tons of dry coal per week, and the waste heat is utilized for steam raising at the plant in water-tube boilers.

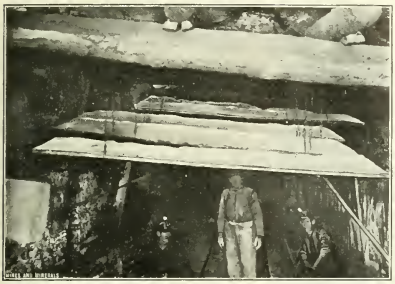


Fig. 5. Transverse Dust Shelves Adopted in a Colorado Mine

Fig. 6. Longitudinal Dust Shelves Adopted in a Colorado Mine

In 1912, however, 50 regenerative Otto by-product ovens were erected, with the necessary extensions to the recovery plant. These ovens are larger than the 60 waste-heat ovens first erected, and will coke 2,000 tons of dry coal per week, yielding from 50 to 60 per cent. of surplus gas of about 500 B.T.U. per cubic foot calorific value after the extraction of the benzol. The gas given off from each regenerative oven per ton of coal per charge (lasting for 36 hours) is approximately 10,000 cubic feet or 70,000 cubic feet per oven per 36 hours, the surplus available for use in the gas engines being about half this volume.

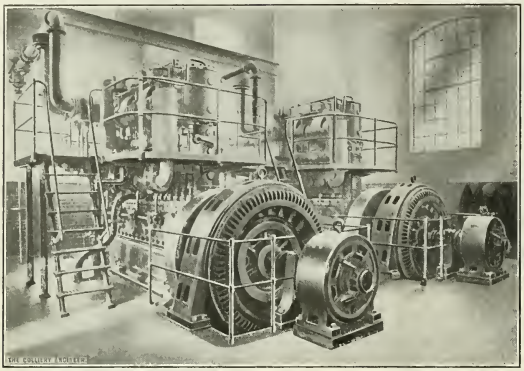


Fig. 1. Gas Engine Using Coke Oven Gas at Grassmoor, England

The gas from the ovens is taken through the recovery plant, in which the tar and sulphate of ammonia are recovered. Creosote scrubbing next removes the benzol. A motor-driven exhauster forces the gas through a main of considerable length to the purifiers, which are located close to the power house. These purifiers are filled with bog ore, a red earthy soil, similar in appearance and consistency to red garden mold, and which is very efficient in absorbing the sulphur in the gas as it is passed through the layers of the ore. As soon as traces of sulphur begin to show in the last section of the purifier, the bog ore is removed and spread out on the ground, where it gradually resumes its pristine virtue, and is again used in the purifier. From the purifier the gas passes to two gas engines of the Westinghouse vertical tandem type, each having four cranks and eight cylinders of dimensions 15½ inches and 16½ inches by 16 inches stroke. The full load of 500 brake horsepower is developed at 300 revolutions per minute.

The engine, which is shown in Fig. 1, works on the four-stroke cycle principle, and having eight cylinders, gives four impulses at each revolution of the crankshaft. By this means an even turning moment is obtained, whilst the tandem arrangement of the pairs of cylinders reduces the length of the machines to half that which would be necessary for the single tier of eight cylinders, besides minimizing the weight and cost of the engines and crankshaft torsional stresses.

Each engine is coupled to a 350-kilowatt Westinghouse alternator, generating three-phase current at 440 volts and 50 cycles. The current is supplied to the two generating panels at the right-hand end of the ten-panel switchboard. A rotary synchroscope ammeter and voltmeter are mounted on swinging brackets at the end of this board, and an automatic voltage regulator is also provided. The third panel, is an indicating and metering panel, the fourth a leakage indicating panel, the fifth to eighth, inclusive, are out-going feeder panels, the ninth a spare, and the tenth a local lighting panel. The various circuits are protected by oil-break circuit breakers and relays. The total load on the feeders is about 1,300 horsepower and consists of haulages, fans, conveyers, picking belts, coke-oven machinery, etc.

Finally, it is interesting to note that, an order has been placed for a third generating set, which will be an exact copy of those already installed and the total capacity of the coke-oven gas-power plant will then be 1,050 kilowatts.

Canadian Mining Institute Meeting

The sixteenth annual meeting of the Canadian Mining Institute will be held in Montreal from March 4 to 6, inclusive. Headquarters will be at the Windsor Hotel. At this writing the provisional program gives 15 papers, divided as follows: 4 on mining; 5 on metallurgy; 4 on geology; 1 on power; 1 on safety, and 2 on scientific management; undoubtedly more papers will be added, as is generally the case.

The New Journal

Attention is called to the enlarged Journal of the American Society of Mechanical Engineers, and the greatly increased scope of its contents. Commencing with the January issue The Journal includes the Transactions, and is the permanent record of the society, the republication in a separate volume as Transactions being discontinued. Therefore, the Journal should be preserved month by month, so that at the expiration of the year the twelve numbers may be bound as a whole, or the papers, foreign reviews, etc., divided and bound separately. An index will be published in the December issue.

Basic Coke

Experiments in Removing Sulphur from Coke by the Addition of Crushed Limestone During the Process of Manufacture

*By J. R. Campbell, B. Sc.**

SULPHUR in coke is almost wholly present as sulphide of iron (FeS) or, perhaps more properly speaking, magnetic sulphide of iron (Fe_7S_8) and as such, readily dissolves in the iron during the smelting process, unless it is carried into the slag by the use of suitable fluxes. In blast-furnace practice this is commonly done by the addition of limestone to the charge of ore and coke. It is generally believed that the sulphur, in whatsoever form it is introduced into the furnace, unites with the lime to form calcium sulphide (CaS) at high temperatures which by virtue of its lighter specific gravity, floats off with the slag instead of dissolving in the metal, from which is deduced the well-known axiom of the furnaceman: "A hot furnace makes low sulphur and high silicon iron, and a cold furnace, high sulphur and low silicon iron," which is true, unless it is run hot and limy, when both the sulphur and silicon will be low.

One of the chief sources of sulphur in blast-furnace operation, is the coke, hence the furnaceman always has his "weather eye" open for the sulphur in coke, especially if it is over 1 per cent. The average coke operator knows how difficult it is to pacify an irate furnaceman after shipping a few cars of coke above the prescribed limit in sulphur.

There is a valid reason why the sulphur in coke ought not to exceed greatly 1 per cent. to make good iron. In round numbers, a ton of coke makes a ton of pig iron, and usually about one-half ton of slag is produced, which must carry all the sulphur in the ton of coke. Thus, if a 1-per-cent. sulphur coke is used, the slag will have to carry about 2 per cent. to remove it completely from the iron. Now the practical limit of solubility of the sulphur in the slag is usually considered to be from 2 per cent. to 2¼ per cent.; in other words, unless the furnace is run very limy, which is detrimental to the lining, the slag should not be expected to hold more than 2 or 2¼ per cent. sulphur. There are rare instances where the slag has carried 2½ or even higher, sulphur for a considerable length of time.

This then is the main reason why coke much above 1¼ per cent. sulphur has but little metallurgical value in the manufacture of low sulphur iron.

Basic Coke.—In view of the foregoing, many attempts have been made to improve the quality of coke from the sulphur standpoint during its manufacture. This paper concerns itself only with the addition of crushed limestone to the charge of coal, or the formation of basic coke. Fulton tried it a number of years ago, and I believe he mentions it in his book on "Coke." Lately the scheme has been revived, both here and abroad, the claim being made that the cause for past failure lay in the fact that the mixtures were not scientifically made.

Table 1. Coal Analysis

	Per Cent.
Volatile matter	39.05
Fixed carbon	52.34
Ash	8.61
Sulphur	2.09

Composition of Ash

	Per Cent.
Silica	47.85
Iron oxide	15.84
Alumina	23.98
Lime	4.41
Magnesia	1.66
Sulphur	1.11

According to the claims of these latest investigators, the limestone must be added in proportion to the ash of the coal to form a slag consisting of a mono-silicate of lime. In other words, the limestone addition is calculated much after the manner of burdening a furnace. To illustrate, the analyses in Table 1 are shown.

From the ash analysis it is calculated that 12½ per cent. of good quality limestone is needed to flux the ash. It is the hope also that the sulphur in the coal will pass into the slag during the coking process. Both the coal and the limestone must be crushed very fine. The coal should all practically pass a ⅛-inch screen, and the limestone, a 20-mesh screen. The mixture must be intimate and thorough.

Tables 2 and 3 show details of a basic coke test in beehive ovens.

Table 2. Analysis of Basic Coke (Ash in Coal About 8 Per Cent.)

Per Cent. Ash	Per Cent. Sulphur	Per Cent. Phosphorus	Per Cent. Lime in Ash	Per Cent. Sulphur in Ash	Per Cent. Limestone Added
13.93	.882	.008	1.65	.264	3
15.85	.918	.010	4.18	.537	5
19.17	.878	.008	5.72	.594	7½
19.90	1.060	.013	6.34	.911	10
27.19	.942	.012	12.24	.998	12½
25.90	1.015	.010	12.13	1.002	15

Table 3. Run-of-Mine Coke Analysis

	Per Cent.
Volatile matter	.750
Fixed carbon	87.070
Ash	12.180
Sulphur	.891
Phosphorus	.014

In the above tests the limestone additions were made gradually, as it was early discovered that the physical quality of the coke was impaired, it being soft and crumbling easily.

About 12½ per cent. of limestone was theoretically required to form the so-called basic coke, but this high percentage rendered it practically worthless. Failure to secure high enough temperatures in the beehive process may be ascribed as the reason. It is an internal combustion process and the large quantities of "carbon dioxide" (CO_2) given off by the decomposition of the limestone, seemed to smother the fire. In fact, the conclusion was reached that "basic coke" by the beehive process, was a total failure from the physical standpoint.

More promise was held forth by the by-product ovens, as it is a retort method, external heat being applied, but here, too, the claims for "basic

*Chief Chemist of the Frick Coke Co. Read at the December, 1913, meeting of the Coal Mining Institute of America.

coke" were not completely realized. Our investigation resulted as follows:

The temperature of the coking mass is not high enough, even in by-product practice, to cause the sulphur to pass into calcium sulphide (*CaS*) during the coking process, as evidenced by the data given in Table 4.

Table 4. Temperatures in Coking Mass Oven No. 47, Test 1

Time	Hole 1	Hole 2	Hole 3
	Degrees F.	Degrees F.	Degrees F.
5:30 P. M.	350	325	275
6:00 P. M.	200	225	200
6:30 P. M.	200	225	200
7:00 P. M.	200	270	250
8:00 P. M.	220	250	240
9:00 P. M.	230	260	250
10:00 P. M.	250	260	240
11:00 P. M.	240	280	240
12:00 M.	240	280	240
1:00 A. M.	280	290	250
2:00 A. M.	380	320	250
3:00 A. M.	690	360	290
4:00 A. M.	1,220	420	380
5:00 A. M.	1,300	720	620
6:00 A. M.	1,360	1,060	822
7:00 A. M.	1,400	1,120	880
8:00 A. M.	1,580	1,550	1,510
9:00 A. M.	1,700	1,700	1,680
10:00 A. M.	1,770	1,770	1,770
11:00 A. M.	1,920	1,920	1,950

Temperature as Pushed

	Degrees F.
Hole 1 (Hoskins pyrometer)	1,814
Hole 2 (Hoskins pyrometer)	1,814
Hole 3 (Hoskins pyrometer)	1,830
On the coke mass (Wanner pyrometer)	1,938
On the oven walls (Wanner pyrometer)	1,992
Flue on No. 46 (pusher side) (Wanner pyrometer)	2,370
Flue on No. 48 (pusher side) (Wanner pyrometer)	2,300

The study of the temperature chart is interesting. Hole 1, for the pyrometer, was located in the charge near the side wall; hole 3, in the center of the charge; and hole 2, at an intermediate point, all on a line at 45 degrees inclination to the axis of the door of the oven. The maximum temperature in the coking mass in good practice, was about 1,900° F., and rather strange to say, even at the beginning of the process it was about as hot in the middle as at the sides, yet raw coal would have appeared in the center had the coke been pushed ahead of time. The flues on either side showed a temperature of about 2,400°F.

The analyses of the coal used showed ash 8.61 per cent., and sulphur 2.09 per cent., and the composition of the ash showed that 12½ per cent. of limestone was necessary to form a flux. These detailed analyses have been given elsewhere.

	Run-of-Mine Coke Per Cent.	Basic Coke Per Cent.
Volatile matter	.90	2.34
Fixed carbon	85.51	72.70
Ash	13.59	24.96
Sulphur	1.62	1.76

Composition of the Ash

	Run-of-Mine Coke Per Cent.	Basic Coke Per Cent.
Silica	46.87	24.06
Iron oxide	15.61	11.54
Alumina	24.12	9.93
Lime	4.21	48.00
Magnesia	1.41	1.16
Sulphur	.86	.61
Sulphur as calcium sulphide	trace	.53

Only one-third of original sulphur in regular coke is changed to calcium sulphide (*CaS*) in basic coke, in which form it is supposed to pass through the blast furnace unchanged and float off into the slag instead of passing into the pig as iron sulphide (*FeS*) does. This percentage is too small to have much metallurgical significance.

Furthermore, the sulphur is higher in basic coke than in run-of-mine coke, due to the lime of the limestone uniting with some of the otherwise volatile sulphur in the coal. It was supposed that the limestone would not be decomposed by the heat of the coking process until all of the volatile sulphur had been driven off, but practically this was not true.

Physical Properties of Basic Coke. Another of the claims for basic coke is that the physical quality is improved by the addition of limestone to the coking charge. Within certain limits this is true in by-product coke—never in beehive coke.

Physical Tests

	Run-of-Mine Coke Per Cent.	Basic Coke With 12½ Per Cent. Limestone Per Cent.
Shatter test	70.50	31.900
Porosity	38.80	43.900
Apparent specific gravity	.90	.934
Real specific gravity	1.47	1.666

The improvement is due to the slag binder if the proper temperature is attained, otherwise the free lime, upon exposure to the air, slakes and causes the coke to crumble and fall apart.

The shatter test is the crucial test. It is made according to the United States Government's specifications, i. e., 4 drops of a given quantity of coke at a height of 6 feet are made and then the broken coke is passed over a 2-inch screen. The percentage passing through constitutes the test. In the above examples, 70½ per cent. of run-of-mine coke and 31.9 per cent. of basic coke passed through the 2-inch screen. The latter figure is about standard for by-product coke.

The porosity and the specific gravity of the basic coke are better than the run-of-mine coke. In fact, we believe it is possible to take an inferior grade of coking coal, and, by the scientific use of crushed limestone in the by-product process, make A-1 blast-furnace coke, where otherwise a total failure would result. As before stated, this is due to the formation of a slag binder in the coke.

By this feature of basic coke, vast quantities of low-grade, or semi-coking coals, would be opened up for by-product use. Whether or not "the game is worth the candle," at present is without the scope of this article. There might be some advantage to the furnaceman in having limestone added to the coke instead of with it. There are also some natural advantages to the by-product operator. The total ammonia yield would be increased by the addition of limestone to the coal, and the percentage of fixed ammonia decreased, which would lessen the work of the stills in the indirect or semidirect processes.

Finally, referring again to the underlying principle of basic coke, i. e., the formation of a slag carrying the sulphur in it, even if this were possible during the coking process, it could not be safely assumed that the sulphur would not get into the iron in passing through the blast furnace just as it does now without the proper safeguards. In fact, we believe the old assumption in this respect, that calcium sulphide passes through the blast furnace

unchanged, is erroneous, and that it would avail nothing, from the sulphur standpoint, to have basic coke. Calcium sulphide is stable only at high temperatures and in a reducing atmosphere. As the matter stands now, we think that the sulphur in basic coke would be acted upon by the iron ore in the top of the blast furnace and changed back into its original harmful form ready to be assimilated by the pig iron, unless slagged off as usual, due to the action of the metallic oxides on calcium sulphide (*CaS*) at comparatively low temperatures.

In view of the foregoing, we conclude: First, that basic coke, in the chemical sense, is not practically feasible, nor wholly desirable. Second, in the physical sense, it has possibilities in utilizing low-grade semi-coking coals for by-product use.

In the discussion following Mr. Campbell's paper, some interesting information developed.

Mr. F. C. Keighley said that he had been informed by a furnaceman that if coke with sulphur as high as 1½ per cent. could be had regularly it would not be so bad to handle, but where it ran .6 per cent. one day and 1.10 per cent. the next, the charges could not be changed to care for it. A uniform quantity of sulphur in coke was not undesirable provided it did not exceed the limit of 1½ per cent.

Mention had been made of mixing lime and coal uniformly. At one time a concern with which he was connected obtained so much flue dust with Mesabi iron ore that they sent some to him to be mixed with the coal to be coked. It was assumed that coal mixed with this dust would save the fine ore and make a stronger coke. At first 10 per cent. flue dust and 90 per cent. coal was tried and a fine looking coke resulted. Next 20 per cent. dust and 80 per cent. coal was tried and this fused and ran all over the oven and when the coke was drawn it was in blocks and the cellular structure was destroyed.

An attempt was made to mix coke breeze with raw coal and if it could have been properly mixed he believed today that it would have been a success. The quantity of breeze went as high as 15 to 20 per cent. in the experiments and the idea was given up because of the poor cellular structure of the coke.

Mr. Sherrick said: In the problem of basic coke making, the heats of formation were not high enough to form a calcium sulphide under 2,600°F., which was above the temperature obtained in the beehive oven with the mixture Mr. Campbell used, and the temperatures of 1,800° F. to 1,900°F. obtained by the by-product oven experiments. (The molecular heat of calcium sulphide is 94,300, an equivalent of 169,740 B.T.U.)

Mr. E. B. Wilson said: If sulphur is gotten out of coal when coking by the use of limestone, it will go into the furnace and require more coke to slag it. It always looked to him that the easier way to get rid of the sulphur was to do so before the coal was coked and for that reason he thought it possible that if the coal was crushed and washed previous to coking a good deal of the pyrite would be removed, and then if sodium chloride was mixed with the coal in a less proportion than Mr. Campbell stated for lime (12½ per cent.), it would have the effect of disposing of a part of the sulphur. The sodium would make a better flux than the lime and the chlorine would drive off the sulphur, that is, act as an oxidizing agent, since it has more affinity for iron. He asked Mr. Campbell if he would not try that, and if he had he would like to hear from him. Mr. Campbell said: I think there is scarcely anything I have not tried in this sulphur game. When sodium chloride is mixed with coal in by-product ovens the ammonia is converted into ammonium chloride and interferes with the direct process. To use the chloride it would be necessary to use the indirect process where the ammonium chloride is put in a still and converted into free ammonia before it is sent to the sulphuric acid baths. In the beehive ovens sodium chloride works satisfactorily and the chemical quality of the coke is improved. It is all right in the beehive ovens, but no good in the by-product ovens where the recovery of ammonium sulphate is one of the principal items.

Ohio Mine Rescue Car

*By William Greelee Burroughs, M. A.**

Although Ohio has not suffered from tragic mine disasters, still the installation of electricity in about 90 per cent. of the coal mines has considerably increased the dangers encountered in mining. Fires may break out, explosions may occur and miners may be entombed at any time. In the event of such a calamity while the State Department of Mines has available rescue equipment stored in the basement of the State House, yet it is impossible for the rescue apparatus to be examined, then packed and hauled to the place of shipment and transported to the mine where it is to be used in reasonable time, and this loss of time may mean the loss of life and property.

Furthermore, in cases of large mine fires or explosions where a number of days are occupied in sealing off the fire zones, the time of a number of district mine inspectors is required. These men are therefore, taken from the duties in their own district, and, naturally, the number of inspections specified by law, cannot be made. If the Department of Mines had a rescue car those in charge of the car could direct the work at the seat of the fire or explosion without taking the inspectors from the usual work in their respective districts.

John C. Davis, Chief Inspector of Mines, for the state of Ohio, designed the rescue car shown in Fig. 1, and made its interior arrangement somewhat different from the other rescue cars. Mr. Davis in planning this car, kept in mind that the car was to be used in emergency cases, and, therefore, eliminated those features which had no

*Oberlin, Ohio.

direct bearing upon its objective use. For instance, there is a living room for one man; no more toilets are to be installed than are absolutely necessary, thus saving room which will be used for the hospital, and other practical features. The car is to be equipped with safety apparatus, hospital arrangement, and first-aid supplies, and it will be stationed at Columbus and kept in readiness to be sent to the place of disaster as soon as notice is received.

The car is not to be used for practice in rescue work and entering deadly gases. All such work is done in the basement of the annex to the State House, at Columbus.

Ohio is in need of a mine rescue car as it ranks fourth in the production of coal among coal producing states of the Union. The Ohio coal fields cover 30 counties in southeastern portion of the state which are included in the northern Appalachian coal field. The rocks of the Carboniferous system of Ohio in which the coal seams are included, covers the surface for about 10,000 square miles. From the coal producing areas now worked in Ohio, the 1912 output was 34,444,291 tons. In the production of this coal 951 mines, large and small, aided. These mines employed 47,234 persons.

During the year 1912, 136 people were killed, that is, one person for 347 persons employed. Of these deaths, 100 were due to falls of roof and coal. Those counties which had the greatest number of fatalities were: Belmont, 37; Jefferson, 20; Guernsey, 17; and Athens, 15.

The writer is indebted to J. C. Davis, Chief Inspector of Mines, for the statistics and other data given in this article.

"The Selling Price of Coal"

*By R. A. Colter**

Wonderful progress has been made in all lines of industry in the way of ascertaining definite and accurate costs of production. In the mining field this has frequently resulted in the reduction of costs, but in most cases an increase will appear on account of more scientific methods of mining and safeguarding of life and property used in production and handling.

In many instances where scientific analysis of cost indicates an increase, that increase is probably more imaginary than real, for the reason that coal has been actually costing what the analysis showed, but the producer has been laboring under the misapprehension that he was putting his coal on board cars for much less. Therefore, when he awakens to the fact that the margin between actual cost and selling price has been greatly overestimated, he immediately wants more money for his product.

Answering the query: "What should be the relation of selling price to cost?" I should say the selling price should be the cost of production plus a reasonable charge for the money invested and risk involved and the cost of selling.

Assuming that the producer has an average plant, his cost is upon an equality with his neighbors and competitors in his own field, his money is no better and worth no more, and his risk is equal but no greater, then, these being known, the proper returns upon his investment are easily established.

The cost of selling depends upon the method, and this phase of the subject is worthy of the same careful research that has been given to the cost production, and might well be more definitely known.

The responsibility for the low returns in the past cannot be shifted entirely to the selling agent, whether he be producer, or an independent person; for ignorance of cost on the part of the producer has often misled the selling agent into ruinous prices. Recently there has been improvement in this direction by the closer relations observed between the producer and the seller. It is not so long ago when it was only necessary to learn at what price a certain grade of coal was being put into a certain market and the price was met or cut, as the case might be, the freight deducted and the balance accepted as the price of the coal. In some instances, however, the process was reversed. The delivery price was made to meet competition but the operator was paid the least he would take and the railroad took the balance for the freight.

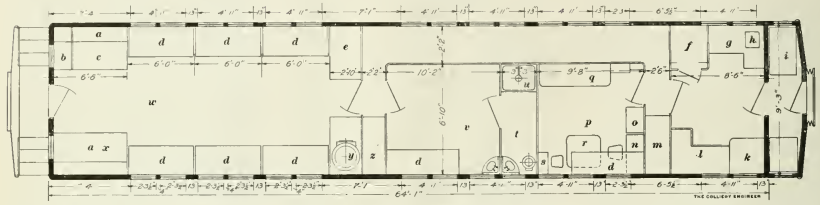


Fig. 1. Plan of Ohio Mine Rescue Car

a, Cabinet for spare parts, locker above; *b*, Locker; *c*, Cabinet for supplies; *d*, Upper berths; *e*, Oxygen pump, charging hoard, etc.; *f*, Refrigerator; *g*, Table with lockers above and below; *h*, Sink; *i*, Coal box; *j*, Kitchen; *k*, Cook stove; *l*, Table with lockers above and below; *m*, Locker; *n*, Desk; *o*, Office; *p*, Engineer's office; *q*, Settee and berth; *r*, Extension table; *s*, Wardrobe; *t*, Bath room; *u*, Bath tub and shower; *v*, Hospital; *w*, Demonstration room; *x*, Locker for safety lamps; *y*, Heater; *z*, Locker.

*Cincinnati, Ohio. Abstract from a paper read at the West Virginia Mining Institute, Charleston, December, 1913.

This condition having been corrected, there sprang up another—the seller who dealt only with tonnage, whose only thought was to move enormous quantities and whose interests lay solely in the commissions.

This can only be remedied by co-operation between the producer and the sales agent, whereby both are brought to see that their interests are mutual and interdependent. The two branches, producing and selling, are distinct, and one requires quite as much business acumen and integrity as the other, but they can be harmonized without prejudice to the consumer.

Thus far we have discussed the selling price of coal upon the basis of fixed production costs and have not taken into consideration contingencies, such as demand, abnormal market conditions, terms of delivery and payment, all of which affect the selling price.

A shipper once remarked "there is no such thing as a market price. It is simply what you can get." This is true in a large measure, but if one is imbued with a knowledge of what the commodity costs, how it is prepared and under what conditions it is produced, one is more likely to get more for it.

The fact that a gas coal from one field is being sold in a certain market at what would be a low price for another gas coal does not necessarily warrant meeting that rate, but should spur the seller into finding another market in which his coal will bring a satisfactory price.

The present knowledge of accurate costs on the part of the producers was not attained in a single day, but required nearly a decade and many conferences. This has, in some measure, been reflected in a more sensible selling price, but it will require considerable work on the part of both producer and distributor to educate the buying and consuming public to a readjustment of prices which is inevitable.

The innovations and reforms in mining coal were accomplished in the face of opposition from those whose cherished ideas and pet theories were upset and destroyed; and reforms in the handling and selling of your product cannot be accomplished without a frank discussion of the ignorance, errors, and abuses attendant upon that branch of the business.

Having assumed that the producer has an accurate knowledge of the cost of production, the question of a reasonable return on the capital invested is next in order. The figures compiled by the Federal Government show that the average returns from all mines in the United States for the year 1909 were 3 per cent. on the capital invested. The coke-making mines of Pennsylvania, including the Connellsville district, were exceptions, with returns exceeding 6 per cent.

The three leading coal producing states showed returns on all mines as follows: in Pennsylvania, a profit of 4.6 per cent.; in West Virginia, a deficit of .9 per cent.; and in Illinois, a profit of 1.7 per cent.

This shows conclusively the necessity of figuring into the selling price a larger percentage on the investment than has been the custom. I leave it with you to decide what is the reasonable return upon your investment and risk.

The cost of selling varies according to the volume and method of marketing and, while it is a profitable field for discussion, there is much misapprehension on the part of the producers as to the present actual cost of doing business, especially where the territory has unlimited proportions.

This is brought about partly by the receipt at the mines, during an active market, of numerous inquiries from persons more or less unreliable, many of whom have only desk room in some large jobbing center, with little or no financial responsibility, whose flattering promises lead the unthinking operator to imagine that his entire product can be sold without any effort. The operator loses sight of the fact that these undesirables are only heard from during active periods, while the legitimate sales agent is hard at work the year round to keep the plant in operation and, at the same time, maintain the market. This is no small job I assure you and it is worthy of the best efforts of any man.

The matter of terms is important. As the measure of a tradesman's profit is determined by the time required for the turnover of his stock, so is this question vital to us. If every one's terms were identical, say 30 days net, it would be a simple matter. But when one considers that the interest for 60 days, at 6 per cent. on $1 coal is 1 cent per ton, on $1.50 coal is 1½ cents per ton and on $2 coal is 2 cents per ton, you can readily see how much of the selling price is squandered in extra time given to buyers.

It is indeed unfortunate that the Federal Government, having done so much toward educating the producer as to the true value of his property, the scientific compilation of his costs and the safeguarding of life and property, has not been so zealous and active in teaching and helping him to procure for his product a reasonable return. This is especially unfortunate when compared with the attitude of governments of other important coal producing countries toward their operators.

The day of individualism has passed and we have entered upon an area of collective effort, which, when rightly directed, will redound to the benefit of all.

I have the faith to believe that in the near future there will be brought about, by popular approval, a radical change in the attitude of our own government toward securing a reasonable return for the product of our mines.

From Thurmond, W. Va., 3,697,277 tons of coal and coke were shipped during the year ending June 30, 1913; enough to load a solid train of standard 50-ton cars, 532 miles long.

Western Kentucky Coal Mining

Problems Arising in Mining—Methods of Working—Remarkable Safety Results Under Difficulties

By Newell G. Alford*

IN THE latest available reports of the Kentucky mine inspector and the United States Geological Survey's "Production of Coal in 1912," it is estimated that the total coal acreage of the state, is approximately 16,670 square miles, of which the western Kentucky coal field embraces 38.3 per cent.; also that Kentucky's coal production in 1912 was 16,491,000 tons, 47.7 per cent. of which was produced in the western field.

This 47.7 per cent., which amounts to slightly less than 8,000,000 tons, was produced by 120 mines, operated by 98 companies. A detailed classification of these 120 mines and their outputs has been arranged by the writer as follows: 21 per cent. produce less than 10,000 tons; 51 per cent. produce less than 60,000 tons; 23 per cent. produce more than 100,000 tons; two companies operating 18 mines produced 2¾ million tons.

The workable coal beds in the western Kentucky field, under development, are with but a few exceptions No. 9 and No. 11 as identified by the Kentucky State Geological Survey. Being more consistent in occurrence, No. 9 supplies about three-fourths of the total output of the field. This seam, which is present in eight counties, averages 5 feet in thickness. While this bed is most generally approached by shafts 300 feet or less in depth, there are depressions in some vicinities which make entrance possible by slope or drift.

Seam No. 11, which is from 40 to 100 feet above No. 9, is the next bed of importance in this field. It averages 6 feet in thickness.

Without exception, the mines of western Kentucky are developed by the room-and-pillar method, with double or triple entries. The triple entry system is used only in the larger mines, where the motor parting is projected in the central entry; the side entries are used for mule haulage and ventilation, respectively. This not only facilitates ventilation, but permits of the motor parting being placed nearer the working rooms, thus reducing the mule haulage. This efficiency is accompanied by the increased cost of driving an extra entry.

Robbing pillars in working No. 11 coal is particularly hazardous and impractical because of the heavy, solid limestone roof. No 11 coal is friable and crushing results where insufficient pillars have been left; also there is the settling of the pillars under pressure with the consequent heaving of the soft, fireclay bottom.

Air Through Old Works.—In some of the mines in this field, old works are used as air-courses. Gases, generated from gob and shale piles, are absorbed and carried along by the air-current.

The difficulties arising from this practice indicate that it should be avoided in all cases, for the numerous wooden brattices to be maintained make it impossible to prevent large leakages in the current. In addition to this, friction resulting from the large rubbing surfaces encountered necessitates an increase in the horsepower of the ventilating equipment.

An instance is referred to, in the territory under discussion, where within the last few years an old mine was abandoned. The intake air was delivered by way of a long, circuitous route through old workings to the working faces. Owing to the long distance which the air had to travel, it finally reached the faces so permeated with impurities as to become one of the contributing factors which resulted in the closing of the mine.

Ignition of No. 11 Coal in Old Workings.—Seams No. 9 and No. 11 with their accompanying shales and gob roof are highly charged with iron pyrites. The atmospheric oxidation of the iron pyrites in the pillars of old works accounts for the generation of considerable heat, slow as the process may be.

It is also believed that the energy expended in crushing pillars of insufficient size, by the overlying strata, is transformed into heat which promotes a rise in temperature.

The consequent expanding of the coal produces crevasses which in turn augment further oxidation. Gradually the condition develops where smoke is followed by a smoldering fire, the gob roof ignites and falls, and this is followed by the ignition of No. 12 coal, where the intermediate stratum of limestone is absent. This last development obtains in cases where the fire has gained sufficient headway.

The prevention of such fires presents an interesting problem, which is solved by sealing off the works liable to such chemical action; or by increasing the quantity of circulating air.

The pursuance of the first method is a popular one because it not only prevents spontaneous combustion, but avoids the impregnation of the circulating air with the gob or shale gases. Since this method can best be worked out by sealing up an entire block of old workings after their abandonment, it has created a tendency on the part of the largest operator in the field to adopt the panel system in working No. 11 coal. To brattice off the old works largely excludes the oxygen necessary to the oxidation of the iron pyrites.

The second scheme is important because conditions arise where it is impossible to follow the sealing off method. Here the end is accomplished through reducing the tem-

*Assistant Engineer, St. Bernard Mining Co., Earlington, Ky.] An abstract of a paper presented at the winter meeting of the Kentucky Mining Institute, December, 1913.

perature of the air in contact with the pillars, by increasing the quantity in circulation and thus preventing the development of heat.

Coal Dust.—In workings where there is a scarcity of mine water, the accumulation of coal dust is, in most cases, given strict attention by the various managements. In keeping with the usual practice, coal dust is cleaned up at intervals and hauled from the mines. Sprinkling is also in prevalent usage in this connection. Humidification of the intake air in the winter months has been universally adopted by the larger operators.

Shooting Off the Solid.—Because of the dangers attending the shooting of coal from the solid, Chief Inspector Norwood, has repeatedly discouraged this practice. In his report of 1891, he comments in part as follows:

"Shooting off the solid is less common now than was the case a few years ago, when the prevalence of this performance invited warning against it from this office. Coal dust is now (speaking of 1891) generally admitted by those who have studied the question, to be almost as dangerous as firedamp. An explosion may occur in any dusty mine and the probability of one exists where shooting off the solid is practised."

Thus, almost two decades prior to the scientific investigation and experiment conducted to prove that coal dust was an explosive agent, the Chief Inspector of Kentucky, together with other advanced thinkers, promulgated the dangers attendant upon the presence of coal dust in our mines.

In connection with shooting coal from the solid, it is worthy of note that the machine-mined coal in western Kentucky was 26 per cent. of the field's output in 1895; in 1911 it was 79 per cent. of the field's output, an increase in 16 years of 53 per cent. in Hopkins County, the largest producing county of the state, 2,550,000 tons of coal were mined in 1912, 99 per cent. of which was undercut by machines.

34-7—4

It is to the credit of the mine inspectors and mine managers alike, that the last report shows an unprecedented increase in the amount of coal mined per fatal accident. In 1910 there were 159,033 tons of coal won for each life lost. In 1911, the production per fatality was 790,222 tons.

When unsupported, the roof of the working places in the No. 9 seam presents a great hazard to the life of the workman. Only by careful inspection and thorough propping, can accidents be avoided. As workings approach crop lines the liability of accident becomes even greater, since the black slate here shows marked tendencies toward disintegration.

In the No. 11 seam, the gob roof, between the coal and the limestone, is even more dangerous than the slate roof of No. 9. After the coal has been shot down, the gob roof will overhang the working places in thicknesses varying from 4 to 30 inches. Being exceedingly treacherous, it will work downward from the limestone cover and without warning, fall.

It is customary with one of the large operators to work pick miners in entries where the roof is such as to necessitate propping too close for the operation of a coal cutting machine.

Overlying these coals is from 10 to 15 feet of light gray shale, which is in the advanced stages of disintegration. On removing all the coal, the shale will fall to heights of 6 to 8 feet; 12 to 18 inches of coal is therefore left overhead as a roof, of which 60 per cent. is reclaimed in the rooms after they have been exhausted. When the coal is mined to its full thickness the rotten overlying shale requires timber sets, thoroughly and solidly lagged, to hold it. In whatever entries are driven, no attempt is made to reclaim this top coal.

The degree of caution exercised within the mines in this field by superintendents and foremen is reflected in the following accident list:

During the year 1911, in the entire western Kentucky field there were only 3 fatal accidents from falls of roof, and 19 minor or non-fatal accidents from the same cause.

Wastes.—A fair estimate fixes about two-thirds as the net portion of coal which is won from the mines. Superlative competition in this field leaves so small a differential between costs of production and sales prices that crop coal, and coal of more expensive excavation must be left untouched and forever lost. With a decrease in the market price, the consumer becomes more exacting and much coal is wasted at the tipples in cleaning the product to make the grades salable at even a small figure. Good coal clinging to lumps of sulphur is often discarded on the waste piles in quantities which more than justify the lamentations of those sincerely interested in the conservation of coal.

A large operator in this field discovered that in satisfying the exacting demands of his customers he was throwing away, on his refuse pile at a single mine, coal, which if properly cleaned, would have yielded him in the neighborhood of $1,000 per month. This shows that if there had been some means of preparing this coal for use, provided that the mine was operating on a very narrow margin of profit, the net value would have done much toward helping the balance on the credit side of the ledger.

Another source of waste in this district is the indifference with which some of the operators plan the future development of their property. On good authority, it is claimed that 50 per cent. of the operators have no idea as to the amount of their original holdings which have been exhausted.

Coincident with this is the general scarcity of technically trained engineers.

Inadequate pillars also contribute to the general waste. Frequently the smallness of pillars results in a squeeze which necessitates the abandonment of the working places.

These rooms must then be recovered by driving "cut-offs," accompanied by additional expense and the loss of coal which is left unmined.

It is taken for granted by most western Kentucky operators that squeezing goes hand in hand with the mining of coal. It is regarded as a necessary evil. It is looked upon as one of the penalties of mining.

Operators working seams other than No. 9 and No. 11, in several instances, find it wholly impossible to recover more than 44 per cent. of their available coal and are required by their conditions to leave more than half of the coal unmined.

Cost Keeping.—Another question needing attention in this field is that of cost keeping. It is perfectly safe to say that 75 per cent. of the operators do not know what it costs them to mine a ton of coal. They get extensions on bills and buy equipments on the instalment plan with interest accumulating, which is altogether within the limits of good management. But in many cases these items are not charged off in keeping with a careful accounting system. At the end of a given period they find their balance on either one side of the ledger or the other, but how it came about there is no telling.

The other 25 per cent. of the managers who keep detailed information on this phase of operation are those that have been producing the larger outputs.

Pond Sites.—Most of the coal acreage in the western field lies inland between the Ohio and Green Rivers, and because of the flat surface, trouble is often experienced in locating reservoir sites with sufficient water sheds. In such cases, extended droughts necessitate either long pipe lines or the hauling of water in tank cars.

Competition.—The conditions which tend to promote keen competition in this field deserve mention. Involuntary suspensions in other fields have in times past created a demand for western Kentucky coal in the large markets outside of its natural sale zone. Limited capital has drawn the conclusion that the lucrative mining of coal means only the sinking of a shaft or the opening of a drift. The comparative ease with which such openings are made in this field, the cheapness of coal "in place," together with short periods of spasmodic prosperity, have brought into being small operations which cannot be sustained by the normal demands of the present market.

In conclusion, it has been the purpose to set forth as clearly as possible the various problems and difficulties which face the coal mining men of western Kentucky. Doubtless the time is coming, when the various physical problems will gain in merit as the operators who have to deal with them progress in economic production.

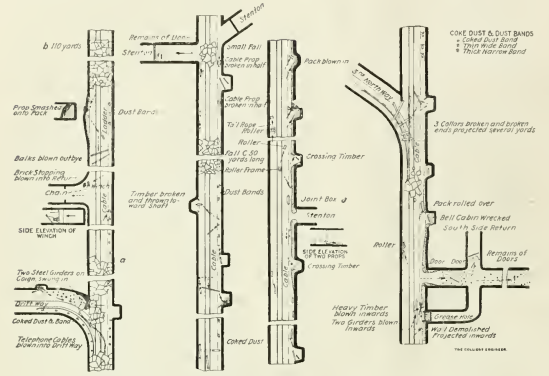


Fig. 1. Auckland Park Colliery—Indications and Direction of Explosive Force

Auckland Park Colliery Explosion

*By James Ashworth**

Thousands of people connected with mining in Great Britain never heard of the Auckland Park Colliery explosion until a report was issued recently by the English Home Office. The explosion occurred October 12, 1912, and the joint report was issued by the chief inspector of mines, R. A. S. Redmayne, G. B., and A. B. Nicholson, the Durham district inspector. The report, after stating that the explosion occurred about 2 A. M., in the Harvey seam, at a depth of 636 feet, considers the matter under the following headings: (1) Description of the Colliery; (2) System of Ventilation; (3) Occurrence of Firedamp; (4) Narrative of the Explosion; (5) Exploration of the Workings; (6) Possible Cause of the Explosion; (7) Summary and Conclusions.

Although no persons were killed, one horse died from injuries received while in the stable near the north pit, and about 22 horses in the 3d north way stable.

It has been suggested that possibly one of the horses in the latter stable, made a spark with his iron shoe, and thus fired an ignitable or explosive mixture of firedamp and air.

From one part of the report it might be assumed that the mine was not a gaseous one, because there had been no entry of "gas" in the report books for more than a month, and yet we have the inference conveyed to us that the explosion undoubtedly originated from an explosion

*Vancouver, B. C.

or ignition of firedamp in the main intake air road. Surely, under these conditions, the source of this gas should have been ascertained with almost absolute certainty. If any of the Government officials tested for gas in the holes caused by the roof caves on the roadway, they do not say what they found. Moreover, they suggest that gas escaped from an old goaf in such quantity that it crossed a road along which 2,000 cubic feet of air was passing, and then by some unexplained means got into the main haulage road, along which a volume of about 23,000 cubic feet of air per minute was passing. A colliery in such a state could not be safe for either man or beast.

A much more common-sense explanation of the presence of "gas" has been afforded the writer by a man recently from Durham; this is that the roof of the Harvey seam, not being strong, invariably allowed gas to escape whenever a fall occurred, and possibly the gas assisted in forcing down the roof. One object of an investigation into the cause of a mine explosion is to obtain facts and wipe out the word mystery, because the latter can only exist where the facts are unknown and are impossible of ascertainment.

From the narrative we ascertain that the banksman saw a flash come out of the shaft with a cloud of dust at 1:55 A. M. Telephones and all signaling apparatus were put out of commission, and the switchboard attendant on the surface said that all the fuses were blown out a little before 2 A. M., the fault detectors showing that there was an "earth" on. The electric current of 2,400 volts was on all the feeder cables and also on the three-score single-armored cable in the Harvey seam. No information is given as to the phones, but the management stated that there was no current in the wires between the shaft and the bell cabin, but there *was* between the bell cabin and the 3d north and north crescent ways. This latter point is of very much importance because the report says that the bell cabin was so completely wrecked, "that no deductions could be made as to whether there had been any sparking or fusing of the wires." The narrative does not say where the earth was made by the 2,400-volt current, and the writer suggests that this was at the first north way where this cable was found torn in two. There was a heavy fall *a*, 20 yards long just inside of this point, followed by other heavy falls thus: one at the drift way had an unstated length; then one of 20 yards going in from the drift way, another of 110 yards was further in at *b*, and another large one *c*, of 50 yards long about half way between the drift way and the point marked *J* on the plan. Under the heading of the "Exploration of the Workings," these falls are reported as having been from 3 to 6 feet in thickness. The reporters state distinctly that the heaviest fall of 110 to 120 yards in length "was evidently the result of the explosion," but no reason is given for this opinion.

The importance of these falls or any one of them does not appear to have been taken into consideration as the *source* of the "gas" which was ignited or exploded, and afterwards did the principal damage. But supposing that the fall of 50 yards by 2 yards thick and say 3 yards wide occurred at one time; we have then 300 cubic yards of rock, displacing the air, putting it under sudden percussion and at the same time bringing down into the roadway a large volume of explosive gas. Such an event provides everything that is requisite to create an explosion without imagining all sorts of impossible sources of the gas supply. Not only so, but the current of air would, for the moment, be stagnated, and everything in the immediate neighborhood would be smashed by the violence of the air percussion. In this manner we find almost direct evidence for the wrecking of the bell cabin and the provision of the arc which ignited the gas mixture. This theory is also supported by the damage in the grease hole and to the doors in the stenton leading into the south side return. All these three places being contiguous to the third north way, it would have been interesting to have known whether or not the horses were burned or singed in this stable.

Assuming that a mixture of gas and air was ignited as suggested, the flame would naturally rush back to the main body of gas and leave the indications of the explosion as they are recorded.

With plain facts like these, which do not need any stretching of the imagination, why should it be necessary to devote four pages of the report to a consideration of "Possible Causes of the Explosion"?

The first paragraph tells us distinctly that the chief element, at any rate in extending the explosion, was coal dust, but that the explosion itself, was initiated by the ignition of firedamp. The next one says that it is hardly conceivable that "gas" could be present on the main intake in such quantity as to constitute an explosive mixture in a current of 23,260 cubic feet of air. The reporters then go into a labored supposition that an old goaf had forced out gas across an air road along which 2,000 cubic feet of air was passing, and they end up this paragraph with the bare statement that "there are several ways in which it might be the means of initiating an explosion," but they do not show where the "gas" did get through into the main intake.

The suggested means of ignition were:

1. Sparks caused by friction of rocks. (The "post" roof was too soft for this.—J. A.)

2. By matches.

3. Electricity. (The point marked *J* on the plans was taken as the center of the developed forces, one going outbye and the other one inbye. The joint box *J* was proved to be intact and without a fault and the cable also.)

4. By electric signaling apparatus. (The expressed difficulty under this heading appeared to be to account

for an explosive mixture of firedamp and air in the main haulage road.)

5. Fire caused by friction of rollers. (This is not seriously considered.)

6. Water blast. (This is something very novel and its application to the case under consideration is said to have "contained the elements of possibility," but it did not assist in elucidating the ignition cause.)

7. Spontaneous combustion. (There had been no gob fire in the mine and none was found after the explosion.)

8. By explosives left in the mine. (Nothing to support this suggested cause was found. There being no shot firing at the coal faces.)

Summary and conclusions: The factor which the reporters found the greatest difficulty in accounting for was the source of the "gas." In a very gassy mine, which this one was, it seems the most natural thing to look for gas in conjunction with a fall of roof. The place of ignition was located at the joint box *J* or within 10 yards on either side of it. This would certainly support the writer's theory (1) that the "gas" came off from the 50-yard fall; (2) as the joint box was found to be perfect after the explosion, that the ignition took place at the bell cabin, and (3), that the flame ran back into the larger body of gas at about the point *J*, or developed into a coal-dust explosion from that point, or from some other point nearer the bell cabin.

The Briquet for Saving Fuel Waste

By Day Allen Willey

Possibly no mining industry in this country has been operated with a greater percentage of waste, than that of mining coal, especially bituminous coal.

No statistics of the percentage of waste can be calculated. It is known that the bituminous output in the various mining districts has increased from 225,828,149 tons in 1901 to 500,000,000 tons annually, and as fully 10 per cent. of the coal mined is not practicable to use, so an idea can be gained of the great yearly loss.

It has at last become possible to make the mine waste a source of value by combining certain materials called binders in proper proportions with the dust and fragments—"slack," making a heat producer, which, when ignited, can be utilized in furnaces. The idea in general is the formation of briquets, compressed into various forms and sizes suited for consumption.

A briqueting plant operated by the United States Bureau of Mines is an illustration of the processes employed in converting lignite and coal slack into briquets. The equipment of the plant comprises two briquet machines (English and American), heating and mixing apparatus, storage bins for the raw fuel, crushers, grinder and disintegrator for reducing the fuel to the desired fineness, machines for crushing or "cracking" pitch, scales, and the necessary elevators and conveyers. There are three storage bins for raw fuel at the plant, two each of 25 tons capacity behind the English machine and one of 50 tons capacity behind the American machine. The samples of fuel to be tested are brought by rail over a spur track leading to the building and dumped from the car into a pit. From this pit a bucket elevator and a 16-inch belt conveyer carries the fuel to the desired storage bin. A tripper on the conveyer discharges the raw fuel into either of the bins back of the English machine or passes it on to be run into the bin back of the American machine.

Under the coal-storage bins and behind the briquet presses, a floor called the "pitch mixing platform" was built 10 feet above the ground, and a runway 60 feet in length provided to roll barrels of pitch up to it. On this "pitch platform" back of each machine are scales having hoppers, into which coal can be drawn from the storage bins and weighed.

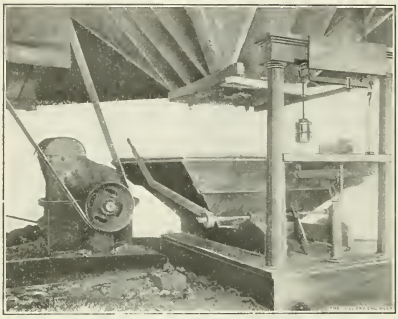


Fig. 1. Coal Weighing Machine

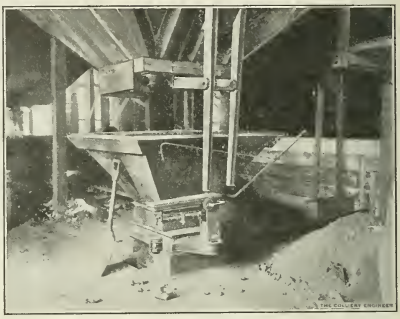


Fig. 2. Pitch Weighing Machine

To make the briquets, coal is drawn from one of the storage bins into the hopper, and after weighing, a slide gate under the hopper is opened and the coal falls into a groove under the scales, whence the plunger pushes it forward at a uniform rate into a hole in the floor. The pitch, which has been broken up by hand and weighed, so that its weight will be the desired percentage of the weight of fuel in the hopper, is added by hand to the coal as it falls through the hole in the floor, the intent being to supply the pitch at a uniform rate. After passing through the hole in the floor of the mixing platform the coal and pitch fall into a horizontal screw conveyer, which not only carries them to the chute leading to the disintegrator, but also helps to mix them. An electromagnet suspended in the chute catches bolts, rivets, spikes, and pieces of cast iron in the material passing under it. This fuel and binder from the chute fall into the disintegrator, where they are ground, the ground mixture being then taken by the bucket elevator to the chute leading to the upper mixing cylinder of the briquet machine.

In this cylinder the mixture is heated by the introduction of saturated or superheated steam, according to the softening point of binder used, and mixed by vanes carried on a revolving shaft. With very dry fuel it is often found advantageous to add water to the mixture. After the fuel and binder are thoroughly mixed and properly heated, the mass becomes more or less plastic and is drawn off through a door in the lower part of the cylinder into another cylinder, the feed-box. From the feed-box the mixture is forced by a plunger into the mold in the vertical revolving table of the press. The plunger speed is 17 strokes per minute, one stroke for each revolution. At half a revolution the mass in the mold is pressed by a system of levers from each end, the maximum pressure being about 2,500 pounds per square inch. Two briquets are formed at each stroke.

The finished briquets are removed from the machine by hand, and either stacked near the machine or placed on a conveyer, and by it loaded directly into a car. They are of rectangular shape, with molded corners, and are 6¾ inches long, 4¼ inches wide, and 2½ inches

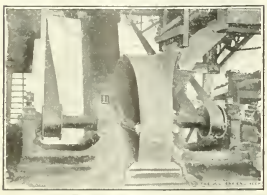


Fig. 3. Disintegrator

thick. Their average weight is about 3¾ pounds. The maximum capacity of the machine is about 30 tons per 8-hour day. When the machine has reached a uniform condition of working, the operator takes the temperature of the briquet mixture and the temperature of the finished briquets.

Briquets of good quality are equal to or better than the original lump coal from which the slack comes. The problem of briqueting is not always that of how to make the best possible briquet, for the slack at hand may be of inferior quality and the best binding material or solidifying element may be too expensive for the conditions prevailing in that particular locality, but to produce at a profit a briquet of satisfactory grade.

For the purpose of a brief comparison, consideration may be given to the binders available for a coal which is fairly easy to briquet. In general, the cheapest binder will prove to be the heavy residuum from petroleum, known as asphalt, 4 per cent. of this binder being sufficient; its cost ranges from 45 to 60 cents per ton of briquets produced. This binder is available in California, Texas, and adjacent territory. Second, in order of importance comes water-gas tar pitch, 5 to 6 per cent. usually proving sufficient. The cost of this binder ranges from 50 to 60 cents per ton of briquets. Third in order of importance is coal-tar pitch. Being derived from coal, this is very widely available. From 6.5 to 8 per cent. will usually be required, and the cost ranges from 65 to 90 cents per ton of briquets. Of local importance, where the price permits, are natural asphalts, and tars derived from wood distillation. The price of each of these binders varies greatly with the locality, but there are doubtless places where they could compete with the binders above mentioned. Wax tailings could be used with an easily caking coal.

Briquets, excellent in all respects, except that they are not waterproof, can be made by using 1 per cent. of starch as a binder, the cost of which is 20 cents per ton of briquets. Extra care is necessary in drying and handling them, adding to their cost. Briqueting of lignite coal offers a peculiarly difficult problem. If the lignite cakes in the fire, asphaltic residues from petroleum or water-gas tar pitch may be used as binder, larger percentages being required than for ordinary coals. The most durable binders for lignites that do not cake are starch, sulphite liquor, and magnesia. Lignites may be briqueted without binder if they are to be burned on grates specially constructed to overcome the tendency to fall to pieces in the fire.

The briquet should be sufficiently hard; but if too hard it is likewise brittle, and therefore less coherent when subjected to rough handling. It is usually advantageous, therefore, to make the briquet of the minimum hardness that will answer the purpose. A briquet can be made harder by using a binder with a higher softening point. Consequently, if pitch is used, the most brittle pitch makes the hardest briquet. Moreover, a larger percentage of the more brittle pitch is usually required. The convenience of a briquet for a given purpose, and hence the extent of its use, depends largely on the size and shape. Heavy rectangular

blocks allow a large output for the investment and are consequently cheaper to manufacture, and are convenient for storage, but must usually be broken when fed into furnaces, in order to promote combustion. To facilitate the breaking, they are pressed with grooves or perforations. Prismatic shapes with rounded edges are also made. Either these or small ovoid shapes are preferred for domestic use. The rounded edges cause much less dust and breakage on handling and insure good air circulation and thorough combustion, but are wasteful in space and make the briquet somewhat harder to ignite.

The output of hollow, cylindrical, polygonal, and ball-shaped briquets abroad is small, the other shapes having proved more generally preferable. A dense briquet will stand the weather better than a porous one. If the coal is finely ground, the briquet has a denser and more polished surface and is then more resistant to the weather. Cracks allow the entrance of moisture, causing rapid deterioration of the briquet. Lignite briquets, owing to the tendency of the lignite to absorb water, do not stand long exposure to the weather as successfully as briquets made of bituminous slack.

The ease with which a briquet will ignite depends largely on the slack used, but can be regulated to some extent. Large briquets ignite less readily than small ones. Sharp edges are an aid to ignition, though this advantage is not so great as to overcome the general preference for the prismatic and egg-shaped briquets. Briquets made from fine slack ignite less readily than those from coarser slack. A dense briquet is also more difficult to ignite.

The briquet should burn with a clear, intense flame, and without odor or smoke—such is its advantages over fuel in the original form. The burning of the briquet and the flames produced will depend largely on the quality of the slack coal used, and on the completeness of the combustion, which can be regulated to some extent in the manufacture of briquets by making them of a shape to insure a good circulation and by the choice of a suitable binder.

So far as the choice of a binder for this purpose is concerned, the principle involved may be summed up in the statement that the smoke does not depend on the total amount of volatile matter in the briquet, but only on that part of the volatile matter which escapes before it is heated to the kindling temperature. In other words, the binder should not volatilize before the temperature is sufficiently high to insure complete combustion of the gases formed.

The successful development of the coal briqueting industry in the United States depends upon a number of conditions. The present drawback to such an industry is the low price of bituminous coal, and especially the small difference between the prices of lump coal and that of slack or fine coal. With anthracite and semianthracite coals, the difference between the price of lump coal and that of slack is often more than sufficient to cover the cost of manufacturing briquets. Concerning still other coals, it is claimed that the difference between the price of the lump and that of the slack is either just sufficient or scarcely so, to cover the cost of briquet manufacture, but the fact that briquets present certain advantages over the lump coal may enable them to command a sufficiently higher price to afford a margin of profit.

The most favorable outlook at the present for the development of this industry is in the use of briquets in locomotives and in domestic furnaces and stoves. It has not yet been demonstrated that, at anything approximating existing prices, briquets can be manufactured for successful use in the ordinary power plants of the country. The results of recent investigations have shown that on boilers requiring forced draft, like locomotive boilers, briqueting so increases the efficiency of the fuel as to more than cover the increased cost of making. Another advantage claimed for this fuel in locomotives, is that the briquet is practically smokeless, which is important, as the smoke from locomotives in railroad yards constitutes a large part of the smoke nuisance of the great cities.

Briquets made from culm have been used several years by the Delaware, Lackawanna & Western Railroad in its locomotives, and with the growing scarcity of anthracite, the vast amount of fuel that now lies unused at the anthracite mines, may in the future prove extremely valuable. In the anthracite field there is a probability of much geater development of briqueting.

Why Technical Editors Seek Euthanasia

Prof. H. H. Stoek, remembering old times, supplies the following newspaper clipping:

"What kind of an engine did you run when you used to work?"

"My! I thought scientific editors had to know a lot. I don't see how you can do it."

"Please tell me if you think my son would be quite safe working on the Panama Canal."

"I am a young man of 19. Would you advise me to be an engineer? What is the best kind, and why?"

"I wish you would send me the answers to the problems inclosed, writing out each step, with explanation. I need them to pass an examination."

"I would like you to send me a list of all the articles that have been written about ventilation and coal dust. I am working up a thesis on these subjects. A 2-cent stamp is inclosed."*

"Your readers will be interested in this little† description of our Type XQ automatic, self-contained, multiple-spindle, self-starting disintegrator. You can use it if you will send us 20 copies of the number in which it appears. We may do some advertising later on."‡

*It wasn't.
†10,000 words and 20 photographs.
‡They never do.

Hisylvania Mine No. 23

Geology of the Hocking Valley and Description of Mining Methods Used in the Sunday Creek, Ohio, Coal Field

By Wilbur Greeley Burroughs*

THE Hocking Valley coal field, including within its area the important Sunday Creek coal field, is one of the two most valuable coal fields in Ohio. Its only rival is the Pittsburg field of eastern Ohio. Almost all of the Hocking Valley territory is drained by the Hocking River, which fact has given the field its name. The most important part of this field includes the northern half of Athena, the eastern edge of Hocking, and the southern third of Perry counties. The Hocking Valley field is subdivided by Professor Orton, former State Geologist, as follows: 1, The Sunday Creek Valley; 2, The Shawnee and Straitsville district; 3, The Monday Creek Valley; 4, The Hocking Valley proper.

The coal bed which has made the Hocking Valley region important is known as the Middle Kittanning, Hocking Valley, or the No. 6 coal seam. Geologically, it is of the Pennsylvanian system, and belongs to the Lower Coal Measures or Allegheny Series.

Professor Orton traced the outcrop of No. 6 coal from the Pennsylvania state line in the Ohio Valley, through the Yellow Creek Valley, under the divide that separates Tuscarawas water from Yellow Creek, to the Little Sandy. It can, also, be connected directly with the Pennsylvania series through the Mahoning Valley, as was first shown by I. C. White.

This No. 6 coal seam extends across the state of Ohio, from Columbiana to Lawrence counties, and is mined in places from the Pennsylvania line to the Ohio River.

A description of the No. 6 coal seam in the Hocking Valley field is given by Professor Orton as follows:

"In structure the Hocking Valley coal has the three benches of the normal Middle Kittanning seam, with some addition of its own. In other words, the great deposit consists of the normal three-bench seam of the Middle Kittanning system covered and reinforced by a Hocking Valley supplementary seam, the latter consisting of one, two, or more benches. The supplementary seam is separated from the original seam

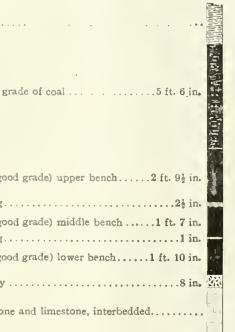

Slate
Poorer grade of coal .....5 ft. 6 in.
Coal (good grade) upper bench.....2 ft. 9½ in.
Parting.....2½ in.
Coal (good grade) middle bench.....1 ft. 7 in.
Parting.....1 in.
Coal (good grade) lower bench.....1 ft. 10 in.
Fireclay.....8 in.
Sandstone and limestone, interbedded.....

Fig 1. Section of Middle Kittanning Coal, at Hisylvania No. 23 Mine

by a thin shale parting, often disregarded in mining, but which for the most part is distinctly recognizable when looked for. The supplementary seam is counted with the upper bench of the normal seam, the whole being known as the top coal. It has a maximum thickness of 10 feet. All the thickness of the Hocking Valley seam in excess of 6 feet, and in many parts of the field in excess of 4½ feet, is to be credited to the supplementary seam. There are numerous irregular partings in this top coal when it becomes thick, only one of which is widely extended and measurably regular. A 4-inch black slate, known as the third slate, and charged with Sigillaria impressions, is found 8 to 9 feet above the bottom of the great deposit, everywhere throughout Monroe Township in the Sunday Creek Valley. It is in the same horizon in which a constant layer of cannel coal is found throughout the western portions of the deposit. The coal above the slate becomes a rider seam, and is too high in ash in most of the field where it occurs to be fairly marketable. It reaches a maximum thickness of 4 feet, but most of it is left in the mines. The composition of the No. 6 coal throughout the Hocking Valley field is fairly uniform. Taken as a whole, it is an open burning coal, but the lower bench burned by itself is somewhat fusible. It is distinctly laminated and holds a moderate proportion of mineral charcoal. It ignites easily, swells slightly in burning, and leaves a white or gray ash. It is well approved for steam generation, for rolling mill fuel, and also for household use, rivaling in this line the block coals of the Mahoning and Tuscarawas valleys."

Throughout a considerable portion of the valley the dip is, according to Orton, quite uniformly 27 feet to the mile, its direction being about 65 degrees east of south, a dip and direction also shared by the strata underlying the coal measures in the Ohio basin, namely the Upper Silurian, Devonian, and Mississippian formations. The reason for this general dip to the southeast was the steady elevation of the Cincinnati arch, a low anticline whose major axis extended through Cincinnati, which began to rise in mid-Ordovician, and due to which folding the present formations are found dipping at right angles to the general direction of the Cincinnati axis of elevation, that is, dipping to the southeast.

The Sunday Creek coal field is the first division of the Hocking Valley coal field that is encountered in coming from the eastward. It was first opened in 1880, when by the construction of the Ohio Central Rail-

*Oberlin, Ohio.

way, the coal was afforded an outlet to market.

As the mining methods in the Sunday Creek district are everywhere nearly the same, a study of any one particular mine will explain those in the other mines of this district.

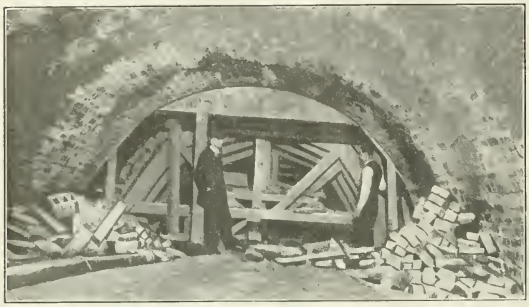


Fig. 2. Bricked Slope, Hisylvania Coal Co., Mine No. 23

The mine taken for consideration is No. 23, of the Hisylvania Coal Co., at Trimble, Trimble Township, Athens County, to the east of Sunday Creek, on the Kanawha & Michigan R. R. The general offices of the company are in Columbus, Ohio.

Here the Hocking Valley seam dips toward the southeast, 24 feet to the mile. A section of the coal bed is as in Fig. 1.

Above the 6 to 8 feet of shale or slate directly over the coal, comes 65 feet of gray, rather coarse-grained sandstone. The cover above the coal averages about 125 feet. The 5½ feet of poorer grade coal is left for the roof of the entries and rooms. The fine grade of coal below is mined.

The analysis of the coal from the Hisylvania No. 23 mine as made by Prof. N. W. Lord, is as follows:

Moisture, 6.20 per cent.; volatile, 36.38 per cent.; fixed carbon, 52 per cent.; ash, 5.42 per cent.; total, 100; sulphur, .70 per cent.

There are a few clay veins, which, according to Orton, were formed in the earlier history of the coal seam, by some inequality of pressure or resistance, whereby the bottom clay was forced in thin sheets through the hardening coal, destroying its continuity, and contaminating it with foreign matter.

Sandstone takes the place of the coal in one portion of this property. The place where this occurs can be seen by noting on the mine map, Fig. 3, where the main slope of the mine turns abruptly from its northeast direction toward the west, in which latter direction it continues until the coal again reappears. In this particular instance, the sudden absence of the coal is due to erosion by the streams which later brought in the sandstone which occupies the place formerly held by the coal.

The surface topography of the region is favorable to mining. On either side of Sunday Creek valley the hills, intersected by narrow valleys, rise from 300 to 400 feet above the flood plain of the river. The level valley of the creek affords a means of easy haulage by rail to the markets, while in the hills and near their bases, lies the coal.

To mine the coal, slopes are driven into the hills until the coal is reached and then the mine is opened.

The main haulage slope *A* of the Hisylvania No. 23 mine has 25 per cent. grade, and is 552 feet in length from its mouth to the point where it becomes horizontal. The slope, which is 12 feet wide by 7 feet high, is lined with brick, as shown in Fig. 2, for a distance of 300 feet from its mouth, when it passes into the massive sandstone formation. Fig. 2 shows the method of constructing the lining with the arch centers in place. At one side of the bottom of the slope are two steam pumps; the other pumps in the mine are driven by electric power. A single track is placed on one side of the slope, the other side being used by the men going in and out of the mine.

North of the entrance to the mine, a distance of about 400 feet, is the air-shaft *B*, Fig. 2, which is 6 ft. × 8 ft. and has one compartment. There is a ladderway for the miners in the air-shaft for use in case of emergency.

The room-and-pillar system of mining is used for the reason that the mines of this region were opened before the panel system came into prominence. This old-fashioned room-and-pillar system used in most of the mines of the Hocking Valley has one particularly bad feature, and that is the difficulty with which a mine fire is extinguished. As the whole mine is more or less continuous there is no fixed point at which

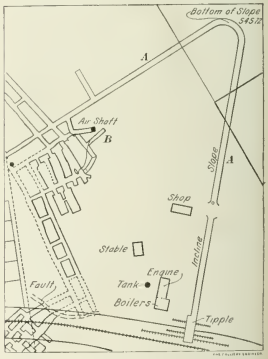


Fig. 3. Hisylvania Mine No. 23

the fire zone can easily be sealed off, as is in mines using the panel system.

In the Hisylvania No. 23 mine, the coal having been reached, the entries are driven on the face and

butt cleats, which makes the entries at right angles to each other.

In the system used, the double entries are 12 feet wide and 6 feet high. Coal pillars, 30 feet wide are left between each entry of the pair. Breakthroughs are made every 60 feet. Cross, or butt, entries are turned every 500 feet along the face entries. Rooms are turned from both entries, the room necks being 21 feet long before the room proper is widened. The rooms are 30 feet wide, 250 feet long, and have 42-foot centers, which leaves a 12-foot pillar of coal between the rooms. Breakthroughs are made every 60 feet, and are staggered.

In mining, the coal is undercut by electrically operated mining machines, which make a 4-inch cut, 7 feet deep across the 30-foot face of the room. The machines undercut 175 feet in 8 hours, and as the coal is suited to machine undercutting the bits of the mining machines will go an entire week without replacing. The roof is firm and exerts no immediate downward pressure affecting the coal, which remains in position after the undercutting is completed. It is necessary to shoot the coal after undercutting with a 3-inch hole in the center and two rib holes. In driving slopes and entries, an electric drill is used, and the shots are electrically fired.

The haulage is done in the mine by electricity and mules. In the main haulage slope, where the single track is placed at one side, the tail-rope system of haulage is employed, a 60-horsepower steam haulage engine being used. The track is single, and is placed in the center of the entries and rooms. The rails used in entries are of 56-pound steel; in cross-entries, 40-pound steel; and in rooms, 25-pound steel. The grade varies from the horizontal to 6 per cent. Twelve cars, each having a capacity of 2 tons of coal, are hauled in one trip. The loaded trips run at the rate of 8 miles per hour; thus it takes 15 minutes to make the round trip, for the longest distance of 1 mile.

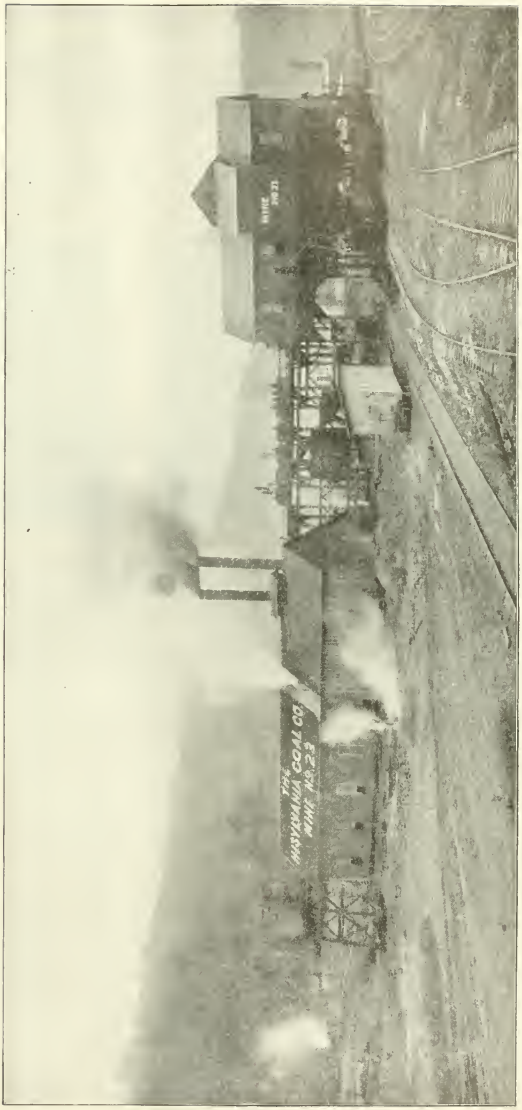


Fig. 4. Surface Plant, Hisylvania Coal Co., Mine No. 23

There is not much timbering needed in the mine, as no timbers are placed in the entries, but in the rooms wooden posts are placed every 6 to 9 feet apart.

For ventilation, there is a 12-foot force fan, run by a 25-horsepower steam engine, which furnishes 26,000 cubic feet of air per minute. It is located 400 feet from the engine house, and 200 feet from the shaft. In the mine, door regulators are used.

There is a little marsh gas (CH_4), in this mine, and also in most of the other mines of the Sunday Creek District, but with good ventilation, the danger from this gas is very slight. There is also no danger from spontaneous combustion, for the mines are wet, and the coal and coal dust are never dry.

The coarse sandstone which is in close proximity to the coal, affords an abundant supply of water, and as the floor of the entries and rooms is somewhat undulating, the water collects in the depressions. Electric pumps are used to discharge the water from the workings to the bottom of the slope where there is a sump 30 ft. × 12 ft. × 12 ft. deep, from which the water is raised to the surface by the two steam pumps mentioned. By pumping from 900 to 1,000 tons of water every 24 hours, the pumps just about keep even with the inflow of water into the mine.

The coal cars, on leaving the mine, are hauled on an incline to the tipple platform, where they are dumped, and the coal passed over a 1¼-inch bar screen. All coal which passes over the screen, goes direct to the railway cars, as lump coal; the finer coal, which passes through the screen is elevated 75 feet by an endless chain of buckets, and is delivered to a revolving screen which sizes the coal before it is distributed to the separate bins, from which it is loaded into the railway cars. The grades of coal thus made are run of mine, lump, nut, slack and nut, pea, and slack. This coal is used chiefly for domestic purposes.

Wages paid the miners are as follows: Cutting with Jeffrey mining machines, in room, $.1050 per ton; same machines in entries, $.1435 per ton; loading in rooms, $.5550 per ton; loading in entries, $.6885 per ton. The miners' work day is 8 hours.

The town of Trimble has a population of 800; three churches which are well attended by miners; two public school buildings; a second-grade high school and a grammar school. The town also has a sewer system, and the streets are paved with brick and lighted by natural gas.

For the information contained in this article relative to the Hisylvania No. 23 mine, the writer is indebted to J. W. Blower, president of the company, E. B. Graham, secretary; E. M. Blower, director; J. H. Moorcfield, mine superintendent; and H. P. Ley, weighboss. Mr. E. M. Blower furnished the mine map and photograph of the tipple.

Mining Exhibit at Panama Exposition

In the Palace of Mines and Metallurgy, at the Panama-Pacific International Exposition, there will be an area of 171,889 square feet, or about 4 acres of floor space for exhibitors. The problem now confronting Charles E. Van Barneveld, Chief of the Department of Mines and Metallurgy, is how to place 343 odd hundreds of thousands of feet of exhibits within about half that amount of space, for every foot of space available in the Palace there are 2 square feet applied for. By the process of elimination that will necessarily follow this condition (even when part of the mining machinery is displayed in a detached Palace devoted to Gas and Fuels) it will be seen that mere representation in the Palace of Mines and Metallurgy will be an honor and recommendation in itself of the object displayed, for it will have been carefully selected and given space on account of its fitness and merit. This fact insures a display in the department of mines and metallurgy that will be representative of the best and the greatest in the mineral kingdom and its tributary realms of mechanics and engineering.

Exhibitors from the mining interests of the West will naturally be amply represented because the confidence of the public in legitimate mining operations is keen in the West.

To illustrate the extent of detail being observed in the assembling of exhibits under this department, it should be said that there will be displays of equipment and paraphernalia used in geological surveys, and instruments and equipment for surface and underground surveys and examinations; the equipment and the methods employed in prospecting, and machinery for quarrying; machinery for and methods of developing the petroleum, coal, natural gas, and artesian waters, also electric and compressed-air apparatus employed in the operation of mines and quarries; machinery and appliances for draining, ventilating, and lighting mines, with exhibits of lamps for testing mine gases. A full line of devices to secure the safety and protect the health of the miner, and a display of the equipment and methods employed in rescue work will attract and hold the attention, not only of the mine operator, whose distaste for damage suits is reasonable, but also of the public, which has occasional cause to note the disasters that follow in the hazard of mining.

M. P. Mahler made some interesting experiments on coal that had been mined 20 years. He found that there was a loss of 26 calories or 46.8 British thermal units; a loss of 1.183 per cent. in carbon; a gain of .169 per cent. in hydrogen; a gain of 2.014 per cent. in oxygen and nitrogen; a gain of 3 per cent. in volatile matter; a gain of .49 per cent. in moisture and .08 per cent. in ash. In bituminous coals there was a decided loss, depending on the kind.

Notes on Haulage Clips

A Description of the Different Types of Clips in Use in North Staffordshire, Showing the Method of Operation of Each

By W. G. Salt and A. L. Lovatt*

THE advent of the mechanical clip for use in mines, was simultaneous with the introduction of the "endless-rope" system of haulage, and since its adoption, innumerable forms of clips for attaching and detaching the mine cars to and from the haulage ropes have been brought before the notice of colliery officials. In the early stages the tendency was to flood the market with all manner of clips, each particular maker claiming some special advantage for his particular design, over and above that put forward by his nearest competitor. A small percentage of these early designs survived the severe tests to which they were subjected, and are now in use to some considerable extent in a modified form; but the remainder failed hopelessly to comply even with the requirements of the most reasonable and least difficult forms of endless haulage, and became obsolete almost immediately after their introduction.

As is usual with all new mechanical contrivances, especially where there are no definite data relating to their design and condition, the only satisfactory method of progress is the "trial-and-error" method. Some makers of clips realized this, and set about to overcome the various difficulties which presented themselves, the general result being to stimulate improvement all around. One by one the difficulties were dealt with, until now there are a number of clips that can be considered satisfactory, but the writers are unacquainted with any single clip on the market at the present day that will successfully fulfill all the conditions that are to be found at a mine. Each colliery manager has his own particular fancy, and knows which type of clip will suit his own requirements.

The object of this paper is not to put forward anything new and original in the nature of design, but to try to tabulate, so far as possible, the kinds of clips that will be best suited to the various conditions of haulages to be found and to provoke a healthy discussion on the subject of haulage clips, as there appears to be so very little reliable information that can be obtained thereon.

The essential qualities of a good clip may be summarized as follows:

1. A clip must be sufficiently strong with a margin of safety, to do the work required, and to withstand rough usage. If, however, the design of the clip is too strong, the desired results would not be obtained; for if the tub or tubs become derailed, serious damage might be caused to the rope or hauling machinery if the clip did not act as a safety valve.

2. Its design and construction should be such that it can obtain and retain a firm grip on the rope when it is attached.

3. The jaws of the clip should have a bearing of at least 70 per cent. on the circumference of the rope, and should embrace all the strands of the rope within a minimum length of the clip jaw.

4. There should be a good margin for wear, and the clip should be capable of easy adjustment by the person using it.

5. The design and construction should be as simple as possible; the fewer parts there are the better, and these should be such as to allow of the clip being easily attached and detached from the rope with certainty, the detachment being clean and certain.

6. The gripping surfaces should be so arranged as not to "kink" the rope under working conditions. If the "kink" effect is reduced to a minimum, the wear on the rope will be reduced, and consequently the life increased.

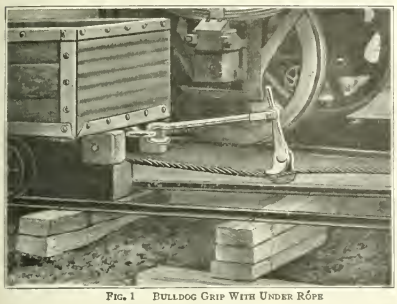


Fig. 1 Bulldog Grip With Under Rope

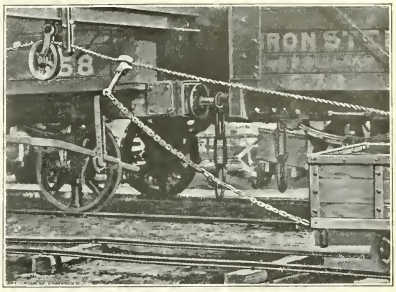


Fig. 2. Bulldog Grip With Over Rope

*Transactions of The Institution of Mining Engineers, Vol. XLIV, Pt. 2.

7. A clip should be capable of being automatically detached from the rope, and ideally should be of such design as to work satisfactorily under any one or all the conditions prevailing at a mine.

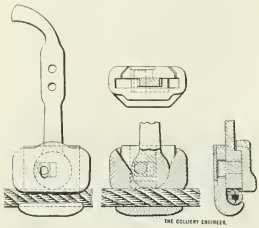


Fig. 3. Details of Sylvester & Weaver Clip

The following controlling factors must be taken into account in the adoption of a clip: Inclination; undulating or varying gradients; level roads; direction of roads (straight or otherwise); and under- or over-rope haulage.

Inclination.—When the inclination of a road is great, a strong clip, preferably of the lever type, with attachments made of the best materials, should be adopted, so that it may be adapted to the varying diameters of the rope. The clips suitable for these conditions are the Sylvester & Weaver, the Stubbs, etc., for under-rope, and the Aspinall for over-rope haulage; but when the inclination is small, other clips may be used with good results, such as the Smallman, and Bradley & Craven.

Undulating or Varying Gradients. When the road is dipping first in one direction and then in another, the clip is required to act in a pulling position or in a holding-back position. Only a few clips are used with certain amount of success under these conditions, such as the Stubbs, Smallman, Bradley & Craven.

Level Roads.—Various types of clip are in use on level roads, and this is the easiest method of applying haulage clips. Those which may be used under these conditions are the Stubbs, Smallman, Drop-down clip, Elswick, the Bradley & Craven, etc.

Direction of Road.—When the road is not straight, a number of clips are successfully used to advantage, but are not absolutely infallible, for when a clip is attached to the rope and is going round a bend there is a tendency for the rope to slip out of the groove of a pulley. If this should happen damage would be caused both to the clip and to the rope, and there is a large amount of wear on the clip and rope. A number of clips may be used under these conditions, such as the Stubbs, Smallman, and the Bradley & Craven.

Under- and Over-Rope Haulage. The writers are not acquainted with any clip suitable for both conditions unless certain alterations are made, and even then these alterations are only possible in the case of a few clips. For the over-rope haulage, lashing chains are used, but latterly have been superseded by

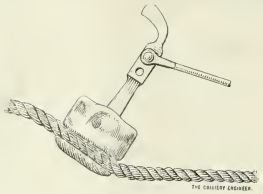


Fig. 4. Sylvester & Weaver Clip

the Swan clip or preferably the Aspinall clip.

Clips may be divided into the lever, the screw, and the wedge types. Examples of the lever type are the Stubbs, Sylvester & Weaver, Smallman, Bulldog, and the Aspinall. Examples of the wedge type are the Stubbs and the Smallman. Examples of the screw type are the Bradley & Craven and the Elswick. There are many other types of clips, because at most collieries clips of special design are used, each particular type being assumed to be the best for the system of haulage employed. Amongst such examples are the Drop-down and the Swan clips.

The lashing chain is extensively used at some collieries, and, although not a clip, it is employed for the same purposes. The chain is about 10 feet long, and has at one end a hook attached to the drawbar of the car. The other end is coiled a few times around the rope and hooked on to the chain near the rope. When the road is undulating, it is necessary to use two chains, one attached to the front end for pulling, and the other attached to the back end for holding back.

The lever type of clip is mostly adapted for inclines, as it adjusts itself to the varying diameter of the rope caused by the weight on the rope. It is a well-known fact that there is a difference in the diameter of a rope working on an incline plane between the top and the bottom. The writers have carried out experiments on a rope 1¼ inches in diameter which had worn down to 1 3-16 inches. Taking several parts of the rope they found a difference of 1-16 inch in diameter on the same point of the rope between the top and the bottom of an incline 800 yards long with an inclination varying from 13 to 20 degrees. These tests were made when there was less than half the working load on the rope. No doubt this variation would be more noticeable if the rope worked on full load, and especially if the rope were new, because then the hempen core is large and the strands not properly bedded in their places.

The screw form of clip does not adjust itself to the varying diameter of the rope, so that it is not suitable for heavy haulage on a steep gradient. A case is known where a youth had to be stationed at a point in a dip to tighten the grip of the clip on the haulage rope.

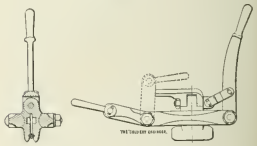


Fig. 5. Details of Stubbs Clip

The following is a description of, and an enumeration of the advantages claimed for each of these classes of clips:

Bulldog clip, shown in Figs. 1 and 2, is the oldest of the lever type. It is simple in construction, and contains only three parts, namely, a lower jaw, a lever with a cam attached to it, and a pivot. The lower jaw has a projection to pass under and engage with the rope on the lower side. The casting is drilled near the top of the plate to receive the small portion of the pivot. The lever is a bar about 15 inches long, with a hole bored in it near the top, to receive one end of the rod or chain which is attached to the wagon. The lower end of the lever forms a cam which contains a hole, drilled eccentrically to accommodate the enlarged portion of the pivot. The lower portion of the cam is hollowed out to form a bearing for the rope. The pivot is a round stud or pin with one-half reduced in diameter, and is riveted in the lower jaw. The lever is fitted on a stud, and secured by a nut and split cotter pin. When the lever is moved forward, the cam is raised, thus opening the clip; and when moved in the opposite direction, the cam is brought in contact with the rope, and as the load is

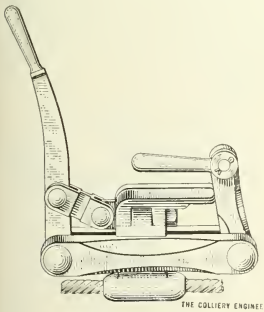


Fig. 6. Stubbs Clip

attached near the top of the lever, the rope is kept taut.

This clip has given a certain amount of satisfaction, but its disadvantages far outweigh its advantages. It can be adopted when the load is against the gradient, as it is dependent on the load itself for its grip on the rope, and it adjusts itself to the varying diameter of the rope.

Sylvester & Weaver clip, shown in Figs. 3 and 4, belongs to the cam and lever form and is composed of a dovetailed box with a portion of one side cut away. This box contains a circular recess, to receive the cam of the lever, in which it moves. The side forming the bottom of the jaw is a main plate, which is dovetailed to slide in the box, and has a jaw at the foot that passes under the rope. Near the top of the plate there is a rectangular space to receive the head of the pivot. The lever bar is about 15 inches long, the foot of

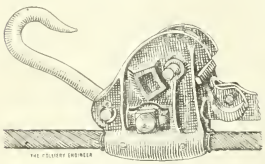


Fig. 7. Smallman Clip

which is formed into a cam having a projection on the side to fit the recess in the box. In this cam a hole is bored eccentrically.

The opposite end of the bar is formed into a handle, and there is a hole near the top for the purpose of connecting the rod, which in turn is connected with the drawbar. The pivot, which passes through the side plate into the cam and fastens the whole clip together, is round and square headed. The pivot is kept in position by a sliding plate secured by a small rivet.

The action of the clip is as follows: When the lever is in the forward position, the clip is open and ready for attachment, and as the lever is brought over, the cam at the lower end engages the rope, the box acting as a guard. At the Norton colliery the clip draws two loads, each weighing 15 hundredweight, up an incline of 1 in 3.

At one time the pivot was a weak point in the clips, and occasionally broke. Experiments were made with several qualities of steel pivots, and were subjected to a dead shearing strain with the following results:

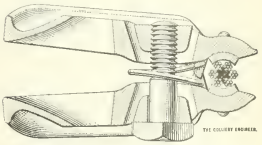


Fig. 8. Section Through Smallman Clip

Material	Tons	Cwt.
Bessemer steel	14	10
Mild steel (case hardened)	17	7
Silver steel (not hardened)	21	12
Nickel steel (not hardened) as at present used	22	10

The connecting-rod was also tested at the same time, the hook of which straightened out with a dead load of 1 ton.

The advantages of this clip over the Bulldog clip are: it has a guard to prevent the cam from splitting or opening the rope; it is a strong clip; it will work on a steep incline with safety; and it will adjust itself to the varying diameter of the rope.

The Stubbs clip is constructed on the new wedge principle, introducing the wedge frame as shown in Figs. 5 and 6. It consists of a frame made in two parts and firmly secured by a bolt at each end, between which works a pair of jaws which grip the rope. To the jaws is secured a lever, which is used for the purpose of attaching and detaching. The frame in which the jaws work is made in the shape of a wedge, and on the outside of the frame are strong ribs to resist strain, the jaws being forced open by the same means of an internal spring. At the back there is a projection which acts in connection with the holding-back attachment, so that when the clip is working in a holding-back position this attachment comes in contact with the projection of the jaw, which tends to increase the grip on the rope.

The clip is automatically detachable, and does not kink the rope when working in a forward position. It adjusts itself to the carry-

ing diameter of the rope, and will work on steep gradients and on undulating or on level roads.

In the Smallman clip, shown in Figs. 7 and 8, there are two side plates loosely joined by a central bolt. The upper parts of these plates are formed with inclines, between which the head of the lever works. The connection between the clip and the cars is attached to the side plates by means of a pin and cotter. When the lever is raised the side plates become free, so that the clip is easily attached or detached; but when the lever is depressed, the head of it slides along the inclines, acting as a wedge, forcing the side plates apart near the top, and causing the plates to come together at the bottom, thus gripping the rope. The clip has been used with success, not only on level roads, but on undulating roads and around bends in the road.

The Bradley & Craven clip, Fig. 9, is practically the same as the Sylvester & Weaver clip, except that the side plate is actuated by a screw which works in the head of the pin and secures the two plates together. This clip is giving satisfaction, and each clip is capable of drawing three cars weighing 2 tons up an incline of 1 in 3 at a speed of 2 miles an hour. The clip is fitted with different types of handles, and is made in three sizes, namely: No. 1, for ropes ½ to ⅝ inch in diameter, length of grip 5 inches; No. 2, for ropes ⅝

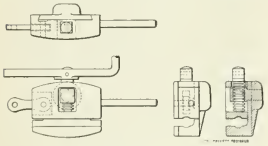


Fig. 9. Bradley and Craven Clip

to ⅞ inch in diameter, length of grip 6 inches; No. 3, for ropes ¾ to 1 inch in diameter, length of grip 6 inches. The clip can be used on level or undulating roads.

The jaws of the Elswick clip, Figs. 10 and 11, act almost like a clamp. The gripping power is produced by two screwed surfaces revolving one upon the other and closing the opening between the jaws. Where the rope fits to the jaws, there is a rod, terminating in

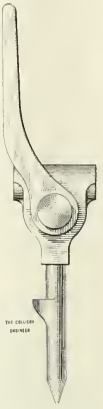


Fig. 10. Elswick Over-Tub Clip

a suitable contrivance for attachment to the drawbar of the car. The clip may be used on undulating roads.

The Collar clip, shown in Fig. 12, resembles a pair of blacksmith tongs. It consists of three parts. The main side is about 10 inches in length, and the top of it is made into a hook or link to attach to the drawbar of the car, the lower end being grooved to fit the rope on one side. In the center there is a hinge joint, to which the top of the small side is secured by a rivet, the bottom being made to correspond with the main side, forming jaws. These are kept together by a hoop, which is made to slide up or down the clip. When the hoop is near the rivet in the center, the jaws are open, and by forcing the hoop down the sides of the jaws when the clip is on the rope, a small grip is obtained, causing the rope to kink, which forms the limit of its working capacity. The clip is cheaply produced and very easily repaired.

The Norton clip, shown in Fig. 13, belongs to the lever-wedge type. It consists of only four parts, namely, a main side, a lever, and a bolt. The main side is about 10 inches long, the inside at the lower end being grooved and extended a little back and front to form a gripping surface. At the upper end is a hook for attaching to the load, and in the center a hinge joint. On the outside, near the lower end, are two wedges a small distance apart and tapering in opposite directions.

The small side is made to correspond at the lower end with the main side; the upper end forms a portion of the hinge joint, and is secured by a rivet. The lever is a bar with a cross piece at the bottom, which projects on the inside and has a square hole in the center; on the outside is a stud for the purpose of detaching automatically. The jaws are operated by a lever; a pin passes through them between the wedges, and is secured and adjusted by a nut. When the lever is in an upright position, the inside projection falls between the wedges and allows the clip to open; when moved backwards, the cross piece engages with the wedges and a good grip is obtained. It is a cheap and light clip, and is adapted to undulating and level roads.

The Aspinall clip, shown in Fig. 14, is used for overhead haulage, and consists of a rectangular box terminating at the top in a jaw which

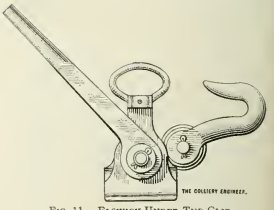


Fig. 11. Elswick Under-Tub Clip

fits on the top of the rope. The lever is fixed in the box by a pin, and a loose crab is attached to the top of the lever, which engages with the rope on the lower side. A chain is fastened to the lower end of the lever, the other end of the chain being connected to the car. The

weight of the car keeps the grip on the rope. At one colliery this clip is drawing one car weighing 10 hundredweight up an incline of 30 degrees.

The clip adjusts itself to the varying diameter of the rope, and the heavier the load is the better the grip.

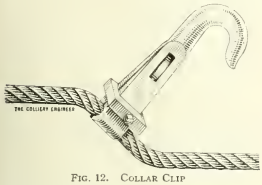


Fig. 12. Collar Clip

The Swan clip, as shown in Fig. 15, consists of two parts, one of which is of flat iron, and attached to the side of the car. The second part, namely, the swan neck, is made of round iron, the rope fitting in the lower portion of the curve. In starting up, the swan neck makes a slight turn, and thus grips the rope.

Table 1. Summary of Particulars of Various Forms of Haulage Clips

Name of Clip	Diameter of Rope in Inches	Circumference of Rope Gripped Per Cent.	Strength Retained Per Cent.	Loads on Clip Hundredweights	Kinking Strain Hundredweights	Length of Leverage Inches	Weight of Clip Pounds	Type of Clip
Collar		50.00	50.00	10	28.00	7.00		Lever
Norton		50.00	83.00	10	15.50	7.00	11¼	Lever
Bulldog	1	59.00	41.50	10	18.10	10.00	28	Lever
Sylvester & Weaver	1¼	78.12	83.34	10	18.10	10.00	31¼	Lever
Aspinall	1	75.60	66.70	10	14.70	7.00	12	Lever
Bradley & Craven	1	50.00	100.00	10	2.69	1.75	24	Screw
Elswick	¾	78.70	83.34	10	5.50	2.50	19	Screw
Smallman	1¼	68.00	83.34	10	4.50	2.50	22½	Wedge and lever
Stubbs		83.34	83.34	10	3.80	1.75	23	Wedge frame

Note.—In the above table a ¾-inch rope is based on a 5-inch lay; a 1-inch rope is based on a 6½-inch lay, and a 1¼-inch rope is based on an 8-inch lay.

The disadvantages of these clips have not been mentioned, because they depend on the particular circumstances under which the clip works. What would be a safeguard at one colliery might be a source of danger at another.

In the attached Table 1, the particulars of the various clips described are tabulated.

The lowest coal bed in Pennsylvania is south of Minersville, about 2 miles from Pottsville, Schuylkill County. This coal bed is 3,000 feet beneath the surface.

Rules for Prevention of Accidents

James E. Roderick, Chief of the Department of Mines of Pennsylvania, has recently sent a circular letter to the general superintendents and general managers in the anthracite region of the state, relative to greater safety in the mines. Some of the suggestions in his letter are equally applicable to bituminous mining. The letter is as follows:

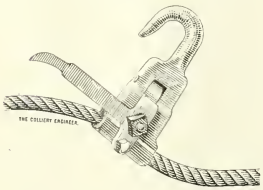


Fig. 13. Norton Clip

General Manager,

Dear Sir:—You are aware that the Department of Mines, through its inspectors, has constantly endeavored to reduce accidents in and about the anthracite coal mines, and I am pleased to say that in this work the managers, superintendents, and foremen have heartily cooperated; but notwithstanding our united and unremitting efforts, accidents, fatal and otherwise, have occurred with great frequency. Still hopeful, however, that some means might be found by which the lives of the mine workers could be better safeguarded, I called a general meeting of the anthracite inspectors at Wilkes-Barre on the 28th and 29th of October, at which time there was a thorough discussion of the causes of accidents inside and outside of mines. The unanimous opinion was that, to meet the existing conditions, additional safeguards beyond the requirements of the present law must be adopted.

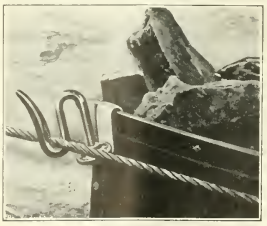


Fig. 15. Swan Clip

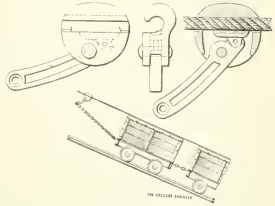


Fig. 14. Aspinall Clip

The most prolific causes of accidents inside the mines are falls, cars, blasts, gas, falling into shafts or slopes, suffocation, and explosives. During the first 11 months of the present year 510 lives were lost inside the mines, as against 463 for the first 11 months of 1912.

If accidents inside the mines are to be reduced, and they should be reduced by one-half, special care and attention must be given to the causes above enumerated. In all mines, but especially in mines where the pitch of the seam is less than 35 degrees, accidents from falls must be given the greatest consideration.

I ask you, in the interest of the safety of the mine workers, to put in practice the following suggestions:

1. To reduce accidents by falls:

(*a*) That in addition to the work of the fire bosses or assistant foremen before the men enter the mine, as provided by law, you will order that two daily inspections of every working place (except in mines

where breasts are being worked ful.) be made by the mine foreman, or an assistant mine foreman, one between 7 A. M. and 12 noon, and one between 1 P. M. and 5 P. M., while the men are, or ought to be, at work.

(*b*) That each mine shall be divided into districts of suitable size and each district shall be placed in charge of an assistant mine foreman.

(*c*) That the mine foreman shall each day enter plainly and sign with ink, in a book provided for that purpose, a brief report stating the general conditions as to safety of the portion of the mine examined by him, describing briefly but clearly, any dangerous conditions that may have come under his observation and the methods adopted to remove them.

(*d*) That each assistant mine foreman shall each day enter plainly and sign with ink, in a book provided for that purpose, a report stating the general conditions as to safety of the working places visited in the portion of the mine allotted to him, describing briefly but clearly, any dangerous conditions that may have come under his observation and the methods adopted to remove them.

(*e*) That the mine foreman shall read carefully the daily report of each assistant mine foreman not later than the following day and shall countersign the report with ink.

(*f*) That the mine foreman and assistant mine foreman on their daily inspection tours shall see that General Rule 12 is being complied with, and, in addition, see that props are properly placed and fastened securely at top and bottom, so they cannot be displaced by flying coal unless broken, but if displaced or broken, they shall be replaced before any other work is done.

(*g*) That the miners be provided with a sufficient number of sawed cap pieces of suitable length, width, and thickness.

(*h*) That the mine foreman and assistant mine foreman in their daily examinations shall insist that the miner remain at work with his laborer in every place where, in their opinion, danger is to be apprehended from falls of roof or coal, and at all times where pillars are being removed.

2. To reduce accidents by mine cars:

(*a*) That all gangways and main haulage roads driven after January 1, 1914, where employes travel and coal is hauled thereon, shall have a clear space of 2½ feet from the top rail of the car to the rib, and also to the timber, which shall be made and continued throughout on the same side of the passageway, if, in the judgment of the inspector, the conditions will permit; and all such space shall be kept free from obstructions. However, if it is found impracticable by the inspector to provide such spaces, then safety holes of ample dimensions shall be made on the same side, and not more than 100 feet apart, which shall be kept clear of obstructions, and whitewashed.

(*b*) That the distance between props and top rails of cars used in breasts shall not be less than 2 feet and said space shall be kept free from obstructions.

(*c*) That the height of gangways and travelingways wherein employes have to travel into and out of the mines, shall not be less than 5 feet 6 inches from the top of sill to roof.

(*d*) That no person under the age of 17 years shall be employed as runner or driver in any mine.

(*e*) That no person except the driver shall ride on the front end of the car, and no person shall ride between cars, and upon the request of the inspector a seat shall be provided for the driver.

(*f*) That in slopes where persons are lowered or hoisted, special cars shall be provided for that purpose, the cars to be approved by the inspector of the district.

(*g*) That in gangways where platforms are used, platforms shall not extend over the top rail of the car.

(*h*) That where chutes are used they shall not extend more than 12 inches over the top rail of the car, unless they are at least 16 inches above the top rail.

(*i*) That when a breast is finished or abandoned for over 30 days, all chutes and platforms that may extend over the top rail of the car shall be removed.

3. To reduce accidents by blasts:

(*a*) That wherever practicable, all blasts inside the mines shall be exploded by an electric battery.

(*b*) That all such batteries used shall be approved by the mine foreman, and he shall instruct the miners as to their use, so blasts can be exploded with greater safety.

(*c*) That only one kind of explosive shall be used in the same hole.

(*d*) That all shot holes in coal shall be tamped to the mouth.

(*e*) That a charge of high explosives in coal, that has missed fire, shall not be withdrawn, nor shall the hole be reopened.

4. To reduce accidents from explosions of gas:

(*a*) That the superintendent shall, as far as practicable, see that the provisions of General Rules 4, 5, 6, 7, 8, 9, 10, and 11 are complied with.

(*b*) That crossheadings between inlet and outlet airways in each split of air when closed permanently shall be substantially closed with walls of concrete, or of stone or brick laid in cement or lime mortar. Provided, however, that the inspector may give written approval of other suitable material in mines with heavy pitches.

(*c*) That crossheadings between breasts, except those nearest the face, shall be closed, and a brattice from the last crossheading shall be erected so as to conduct the air to the face. Provided, however, that the closing of such crossheadings and the erection of a brattice may be omitted on the written consent of the inspector.

(*d*) That each breast when finished shall have a crossheading driven at the face to prevent an accumulation of explosive gas.

(*e*) That every permanent overcast or undercast built hereafter shall be substantially built of incombustible material.

(*f*) That in each mine there shall be telephone connections between the surface and all important parts of the mine, and an attendant shall be on duty at all times at the telephone on the surface.

5. To reduce accidents in shafts:

(*a*) That every shaft and also every slope with an angle of over 35 degrees, wherein men are lowered and hoisted, shall have safety gates at the top and also at each intermediate lift thereof, which shall be controlled by cage, gunboat, or car.

(*b*) That where men are lowered or hoisted in such shafts or slopes, a safety device that will prevent overwinding and also control the speed of cage, gunboat, or cars at all times shall be attached to the engine.

6. To reduce accidents by explosives:

(*a*) Not more than 5 pounds of high explosives shall be taken into a mine at any one time by any one person, unless more is required for use in that shift.

(*b*) That high, or permissible, explosives shall not be sold for use in mines, unless the name of the manufacturer and name and grade of explosives are stamped on each stick.

(*c*) That detonators shall at all times be kept separate and apart from other explosives until required for use.

(*d*) That no frozen explosives shall be sold or given to any employe.

(*e*) That no person shall thaw explosives inside or outside the mines, except by the method recommended by the manufacturer.

(*f*) That black powder shall not be sold loose in kegs, cases, or packages, but shall be sold in cartridges, and shall not be taken into the mine, except in non-conductive receptacles.

(*g*) That detonators shall be sold in boxes of ten in a box, and not more than one box shall be sold to any one person at one time unless more are necessary for a day's work.

7. To prevent accidents from electricity:

(*a*) That when electric power is used in and about the mines, it shall be cared for in accordance with Article XI of the Bituminous Mine Act of June 9, 1911, so far as it can be applied to anthracite mines.

8. Gasoline and oil:

(*a*) That 6 months after January 1, 1914, locomotives using coal, gasoline, or oil shall not be used inside of any mine, and the use of gasoline or oil for generating power for any other purpose shall also be prohibited.

9. To reduce accidents by cars on surface:

(*a*) That railroad cars and other cars shall be handled with care.

(*b*) That safety switches shall be placed above all breakers, so as to safeguard the loaders, and at any other place when requested by the inspector.

10. To prevent accidents from suffocation in chutes:

(*a*) That no person shall shovel coal in any pocket until the loader is notified.

(*b*) That the loader shall not load from any pocket until he is informed that the person or persons are out of the pocket.

11. Rescue and first-aid corps shall be established:

(*a*) That rescue corps and first-aid corps shall be established at each colliery or at each group of collieries, as agreed upon between the superintendent and the inspector.

You are kindly requested to order that the suggestions given in this letter be carried out, as it is the sincere desire of the Department, and I know it to be your desire also, to make a record for the year 1914 in the way of reducing accidents in the mines.

Kindly acknowledge receipt of this communication.

Very truly yours,
James E. Roderick,
Chief of Department of Mines.

To Prevent Mine Doors Being Left Open

*By Simon H. Ash**

The Mining Law of the state of Washington requires that all main doors in any coal mine shall be so placed that whenever one door is open another which has the same effect upon the same air-current shall be and remain closed and thus prevent any temporary stoppage of the current.

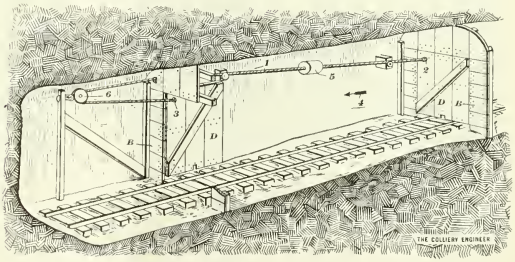


Fig. 1. Mine-Door Closing Apparatus

Although doors on the main haulage roads have been nearly entirely done away with, there are instances in which their use is unavoidable and through which men have to travel to and from their working places. While the usual precautions are taken, there are times that they are left open, due to carelessness on the part of the miner who leaves the doors open for the fellow behind him to close and who does not happen to come along, and due to oversight or neglect on the part of the

*Deputy State Inspector of Coal Mines, Seattle, Wash.

mine official whose duty it was to see that the doors are closed. If gas should accumulate before the men reach their working places, or if a fall should occur in the old workings and release a large body of gas, instead of it being safely carried away from the men it may be brought down upon them, due to the derangement of the air caused by leaving the doors open.

To comply with the mine law and to eliminate as far as possible the dangers resulting from doors being left open the arrangement shown in Fig. 1 is in use at the Northwestern Improvement Co.'s Mine No. 3 at Roslyn, Washington. The doors in the main manway are fitted as shown, and the results are very satisfactory. Mr. Thomas Ramsay, foreman of mine No. 3, is the inventor of the system. The two doors *2* and *3* are connected as shown by means of a ½-inch crucible steel wire rope, one end of which is connected to an eyebolt in door *2*, the rope passes through a hole in the door frame *B* of door *3*, over the pulley *6*, and the end is fastened to an eyebolt in door *3*. An adjustable weight *5* is fastened to the rope *1* which keeps the rope tight over the pulleys when the doors are closed. The weight also helps to close the door that is open and tends to keep the doors closed if the air is reversed. The sag in the rope is enough so that when one door is open the sag is taken up and it is impossible to pull the other door open without closing the former. In case of a mine fire, or if for any other reason it is found advisable to reverse the air, the doors, if they could not be reached, although opened a very slight distance by the air would not be entirely opened as would probably be the case otherwise.

According to figures recently given out, the state of West Virginia could supply enough bituminous coal to keep the world going for the next 50 years if all the other coal mines were to be shut down.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Economic Geology, by Charles H. Richardson, Professor of Mineralogy and Economic Geology, Syracuse University, 12 mo, cloth bound, 6″ × 9″ pages. McGraw-Hill Book Co., New York, publishers. Price $2.50. This book contains 320 pages including index, 12 chapters and 133 illustrations, and is based on a series of lectures which the author has been compiling for more than 20 years. It treats only of metallic ores in addition to the chapters on the origin of ore deposits. The metals are arranged, with the exception of the precious and rare metals, in the order of their group separation. It seems to be a *pot pourri* of ore deposits, mineral geography, economic geology, likewise general mineralogy and metallurgy.

The Twenty-Second Annual Report of the Mining Department of Tennessee for the year 1912, has been published. Address George E. Sylvester, Chief Mine Inspector, Nashville, Tenn.

Colliery Manager's Pocket Book, Almanac, and Diary for 1914. Edited by Hubert Greenwell, Joint Editor of the *Colliery Guardian*. This, the forty-fifth edition of this annual, contains 450 pages, in addition to diary, memoranda, etc.; nevertheless, it is easily accommodated to the jacket pocket. Here the colliery official has the whole of the numerous Acts and Regulations relating to British coal mining, accompanied by statistics and data on all subjects that come within his purview, such as the analysis and character of coal, the strength of materials, machinery, ventilation, surveying, concrete, rescue and ambulance, electricity, valuation, depreciation, explosives, etc. The "Pocket Book" also contains lists of institutes, trade societies, inspectors of mines, educational institutions, etc. Much of the information is not to be obtained from any other source. Prices: cloth, 2s.; roan, gilt edges, 3s.; calf, gilt edges, 4s. 6d. Published by the Colliery Guardian Co., Ltd., 30 and 31 Furnival St., Holborn, London.

The Electrical Blue Book, 1913-14. The sixth edition of the Electrical Blue Book provides in the most compact form possible complete information respecting the rules of the National Electrical Code, the list of Approved Fittings as published by the Board of Fire Underwriters, and a visualization of the products of the leading manufacturers of electrical material which have passed the tests recommended by the National Fire Protection Association as conducted by the Underwriters' Laboratories. The list of Approved Fittings is arranged alphabetically both with respect to the classification of material and the manufacturers of each material listed.

Additional features are practical chapters on the following subjects: "Common Sense Methods of Wiring Calculations for Direct-Current and Alternating - Current Circuits"; "Treatment for Electric Shock"; "Street Lighting Schedule"; "American Institute of Electrical Engineers, Code of Ethics"; "Industrial Motor Applications, Giving a Chapter on Care and Handling of Motors and the Motor Requirements of Machinery Utilized in Various Industrial Applications"; "Data on Illumination Calculations"; "Chart for Graphic Analysis of the Two-Rate Power Schedule for Central Stations."

The book is 9 in.×12 in., handsomely bound in stiff cloth covers. It is published by the Electrical Review Publishing Co., 608 S. Dearborn St., Chicago, Ill. Price $2.

The North Company Coal and Shipping Annual for 1913-14, deals practically with coal production and shipping matters in Great Britain. It is published by the Business Statistics Co., 20 Victoria St., S. W., London, England.

The Topographic and Geological Survey of Pennsylvania, has issued a report for 1910-1912 on the Economic Geology of Pennsylvania. Address, Harrisburg, Pa.

Mining at Lowe, West Virginia

New Method of Coal Cutting, and the Modern Tipple of the Weyanoke Coal and Coke Co.

By William Z. Price

THE Weyanoke Coal and Coke Co. is developing its property at Lowe, W. Va., in a way which will make it the leading operation in that section of the state.

It has already become one of the largest producers along the Pocahontas, Bramwell, and Wenonah branch of the Norfolk & Western Railroad.

Fig. 1. Coal on Shaking Screens

Fig. 2. Picking Table and Loading Boom

There are two features of special interest at the mine that claim attention; they are the method used in cutting the coal, and the new tipple.

In bituminous coal mining elsewhere, the coal is usually undercut. The machine is run up to the place on a truck, unloaded, and fixed in position. When the cut is completed, the machine must be laboriously loaded on to the truck again before it can be moved to the next place.

Throughout most of the mine workings at Weyanoke, there is from 5 to 8 inches of draw slate between the coal and the roof. It was to get rid of this draw slate most easily and thoroughly that the new way of cutting coal was devised. A Jeffrey breast machine was loaded on a home-made truck and jacked up in such a position that it would cut into the coal just under the draw slate at an angle of approximately 20 degrees; this varied, however, according to the thickness of the coal and draw slate. Fig. 3 shows how the cut is made in the coal. This method of cutting enables the miner to get rid of the slate easily and to allow a properly placed charge of powder to break up the coal into blocks. By overcutting the coal in this manner the "bug dust" from the machine practically takes care of itself. The machine is kept on the truck at all times and moved around by an electric locomotive, which remains coupled and gives the truck the stability needed during the cutting of the coal. A machine runner and helper can cut 15 places in 10 hours.

The mine is equipped with three of the above machines, Morgan-Gardner undercutting machine, and a Jeffrey shortwall machine which is used in one section where a "middleman" of 3 to 10 inches is encountered and also hard draw slate. The advantages of the breast are cleaner coal produced and a reduction of almost one-half in the cost of cutting.

The coal is hauled to the tipple by a 10-ton electric locomotive and dumped over a home-made push-back dump. The coal drops into a wooden hopper, steel lined, and passes out on to a feeder which is made up of 2-inch iron pipes, 4 feet long and spaced 18 inches apart, rolling over a sheet-iron table. The feeder is set horizontal and is 11 feet long, the pipes being held at each end by a sprocket chain. The speed of the feeder is adjusted by changing the sprockets. At present it is regulated to feed 200 tons per hour. Owing to there being no vibration to this feeder the discharge is continuous, and it is less expensive and more efficient than a reciprocating feeder.

Fig. 3. Section of Coal Seam

The conveyer which receives the coal from the feeder is 90 feet long and is a pan conveyer instead of a retarding one; this enables the coal to be picked as it passes down the incline. The conveyer is 4 feet wide with 9-inch pans, carried on a 16-pound rail by 3-inch chilled steel rollers. Every eighth pan the pins binding the pans together extend all the way across and become the

wheel axle. The bone is picked out and thrown into bins extending 40 feet on each side of the conveyer line, and from there it is let into the dump cars and taken to the bank. Eventually the company will erect a conveyer line which will take what bone is required for fuel to the power house, as this bone burns readily, and although it is high in ash, is an economical fuel.

The conveyer discharges the coal into a chute fitted with a fly gate. With the gate open, the coal is allowed to by-pass into a wooden hopper, steel lined, placed directly over the inside loading track. The bottom of the hopper is fitted with an undercut gate. This enables the direct shipment of run-of-mine coal.

Fig. 4. View at Weyanoke, Tipple in Distance

When the coal is to be sized, the gate is closed and the coal passes on to tandem shaking screens of the roller-face type, where it is sized as "lump," "egg," and "slack." The slack passes through the upper screen into the above mentioned hopper. The egg and the lump coal are segregated on the lower screen and pass into accumulating chutes which discharge on to combination picking tables and loading boom, thus allowing the sized coal to be thoroughly cleaned before being delivered into the respective cars on the railroad tracks below. The picking table is 35 feet long, of the same width, and moves at right angles to the conveyer. At the end of the tables the coal passes on to the loading booms which are 25 feet long and constructed of steel framework. The pans go the entire distance of 60 feet and return.

The booms are raised and lowered by Sprague electric hoists insuring quick action and no breakage as the coal passes into the cars. A 25-horsepower General Electric motor operating with 250 volts of direct current drives the feeder, screens, and the conveyer. The feeder and the screens are operated through clutches which can be thrown out if desired. The power for the picking bands is supplied by a 10-horsepower General Electric direct-current motor.

The tandem shaking screens previously mentioned, are fitted with veil plates so that "run-of-mine" can be carried on to the picking tables and booms when sized coal is not being shipped. The screens are so arranged that any number of these plates on the slack screen can be raised and the percentage of "lump" in the "run-of-mine" can be regulated as desired.

The entire tipple is constructed of white oak timber and covered on the roof by Johns-Manville, 4-ply asbestos roofing and on the sides with corrugated ingot iron. To provide ample light in addition to the many windows, transparent rubber glass skylights are used. All the timber joints are "dapped" 1 inch, which provides a shoulder to carry the load instead of relying on the bolts alone. All the splices in the timber are lapped.

At the head of the tipple but one man is needed to dump the coal, and one man on the loaded track to start the cars. The dump, being of the push-back type, rights the car after dumping and it runs by gravity to the empty track.

The operation at Weyanoke represents the expenditure of a rela-

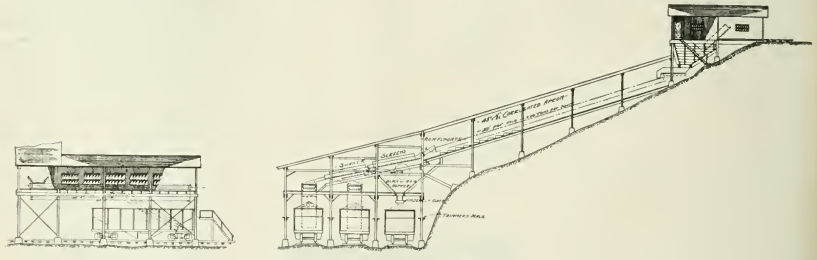


Fig. 5. Cross and Longitudinal Sections of Tipple at Weyanoke

tively small amount of capital but a maximum showing for the money invested. Repeatedly it has produced a greater tonnage than the allotment made by the railroad and it bids fair to become one of the leading individual companies in West Virginia. The present status of the mine is unquestionably due to General Manager R. D. Patterson, of Dayton, Ohio, and his able assistant, Superintendent John T. Morris, formerly connected with the Lehigh Valley Coal Co., at Wilkes-Barre, Pa.

Analyses of Mine Explosions*

The German Firedamp Commission reported in 1891; nevertheless, it is believed that the following analysis of the report will be of interest to very many engaged in coal mining. Because of its being so old it will be new, therefore, the more it is studied, the more it will be appreciated.

According to the data obtained by the Commissioners, the firedamp causing the explosions was produced in the following manner:

	Explosions	Per Cent.
By sudden outbursts of marsh gas from blowers, fissures, or bore holes	236	16.3
By slow and steady exudations of the gas from coal or stone, from fissures and the like	1,077	74.4
Outbursts in consequence of the sudden fall of stone or coal	61	4.2
By secondary accumulations in working places, old workings, goaf, etc.	74	5.1
Totals	1,448	100.0

The explosions which have taken place between the years 1881 to 1884 may, as regards their date of occurrence, be tabulated as follows:

January	145
February	140
March	163
April	124
May	130
June	125
July	123
August	133
September	141
October	146
November	140
December	156
Total	1,666

It will be noticed that during the cooler months of the year the number of explosions increased, owing, no doubt, to the dryer condition of the mine.

*German Firedamp Commission Report, 1891.

The probable direct causes of the ignition of the firedamp in coal mines, may, so far as they are investigated, be put down as follows:

	Explosions	Per Cent.
1. The use of naked lights	918	56.8
2. Matches and smoking	18	1.1
3. Illegal opening of safety lamps	115	7.1
4. Defective safety lamp or injury to it during work	113	7.0
5. Heating of the gauze of safety lamps	26	1.6
6. Passage of the flame through the gauze:		
(a) In consequence of careless handling of the lamp	167	10.3
(b) In consequence of too rapid an air-current	22	1.4
7. Shot firing	237	14.6
8. Ventilating furnaces	1	.1
Totals	1,617	100.0
Not investigated	49	
	1,666	

It will be observed that of the 1,617 explosions investigated, 56.8 per cent. were due to naked lights; 14.6 per cent. were caused by shot firing before the days of permissible explosives; and 11.7 per cent. were due to flame passing the gauze.

So far as the influence of the depth was determined, the commissioners divided the explosions (fatal and non-fatal) as follows:

	From 1861 to 1881, 583 Explosions Out of 1,240 Were Investigated Per Cent.	From 1882 to 1884 420 Explosions Out of 426 Were Investigated Per Cent.
At depths above 328 feet	8.0	5.7
At depths from 328 to 656 feet	43.6	26.5
At depths from 657 to 984 feet	39.3	42.6
At depths from 985 to 1,312 feet	6.9	20.0
At depths over 1,312 feet	2.2	5.2

	Explosions	Per Cent.
In rise places (inclined planes, crossings, pillars, etc.)	774	47.4
In level workings (stone drifts, and other exploring places)	541	33.1
In working places	273	16.1
At other points in the mine (shafts, bore holes, dip places, old workings, etc.)	45	2.8
Totals	1,633	100.0

To determine what, if any, influence the time of day had on the explosions, the working shifts were analyzed.

According to the working shifts, the explosions took place as follows:

Day shift	967
Afternoon shift	315
Night shift	224
	1,506
Not investigated	160
Total	1,666

These again were subdivided to the different times of the shift, as follows:

Commencement of shift	798
Middle of shift	474
End of shift	218
	1,490
Not investigated	176
Total	1,666

The data were also grouped according to the employment of the workmen as follows:

Descending into the mine	302
Inspection of the working places, and freeing these from firedamp	144
Ordinary work at the face	520
Blasting	75
Walling and timbering	35
Miscellaneous work	17
When off work	48
Going into old workings or in the goaf	86
Returning to bank	17
	1,244
Not investigated	422
Total	1,666

The Advantages of Machine Mining

*By A. J. Moorshead**

There are few matters of more interest in economic mining than the relation between the amount of screenings produced by machine mining and the amount of screenings produced in hand mining.

In my experience, coal mined by machinery contains anywhere from 3 to 10 per cent. less screenings than when the same coal is shot off the solid.

At our Mount Olive plant some men have for years produced an average of 300 tons per keg of powder, while other men do not average more than 200 tons per keg, and many less. The same is true with machines at our Divernon plant, showing that some men know just where to drill and the quantity of powder to use, while others never were good judges in drilling or in the preparation of shots, and never will be.

Coal in the same seam varies in hardness. For instance, in the Belle-

*President of the Madison Coal Corporation. A paper read at the Illinois Mining Institute, 1913.

ville district the coal is hard, when found directly under the limestone, and when shot off the solid will give practically as little screenings as when mined by undercutting machines. The Belleville coal is the No. 6 Blue-band seam, yet the same coal seam in the Mount Olive and Staunton districts is much softer, more friable, and will produce more screenings when shot off the solid than when mined by machinery.

About 20 years ago some thought was given to the subject of discarding machines and shooting off the solid, but it was found that skilful shooters who could break 300 tons per keg of powder after the machines, produced a very poor quality of mine run when shooting off the solid. So much screenings were made at the Mount Olive colliery it became a machine mine for all time to come.

The No. 5 coal seam at Belleville, if skilfully shot should produce practically as good quality of coal off the solid as would be the case were it undermined by machines; but the No. 6 seam, in Williamson County, will vary greatly in the quantity of screenings produced in favor of the machines; for this reason as well as for safety, the Madison Coal Co. expects to install machines in its two mines located near Carterville.

At the present time only from 27 to 30 tons of coal per keg of powder are broken at those plants, but with the use of machines, it is expected that from 100 to 130 tons per keg will be produced, and if so, the percentage of screenings will undoubtedly be reduced 7 to 10 per cent.

When using electrical undercutting machines, much depends upon the local management and the supervising officers who have charge of the men at the face. They must see that the coal is properly snubbed with shots, the maximum size of which has been determined by experiments and then make a rule by which all of the miners shall be governed; and if all of the places are properly snubbed and the contract carried out with reference to the removal of the snubbings, then, with care exercised in the drilling and the quantity of powder used, a much greater percentage of lump will be secured and a far better marketable grade throughout than is possible by shooting off the solid.

There seems to be as much difference in the activity and thoroughness of mine managers as in the grades of coal from the same bed. Where the manager is thorough and on the job all the time, watching to see that the miners properly snub their coal and instructing them in shooting, he will produce an infinitely better grade of coal from the same seam than comes from a mine which is under the management of an indifferent person.

In a general way, where there has been failure in the use of machines in so far as the grade of coal is concerned, it is more often the fault of the local management than the coal; and wherever possible machines should be used, for, even though conditions are such that they produce the same quantity of screenings as when shooting off the solid, yet there would be increased safety, and that is the first and most important thing that should concern us.

Great loss of life, severe injuries, and great suffering have followed the use of explosives, where solid shooting has been the method of mining, but where machines have been used, there have been few serious accidents or injuries to persons from the use of powder, and it is this point particularly that induced me to recommend the use of machines at the only two plants in southern Illinois where we have been shooting off the solid. At one of those mines, two shot firers lost their lives, and how many more would have been sacrificed had there been more than those two men in the mine at the time, I don't know.

We have had several so-called "windy shots" that have expended their force down the entries and done some damage, and it is the only condition existing at our plants that really alarms me, and I would naturally be uneasy, no matter where placed, if solid shooting were our mining practice.

In my own experience, from every point of view from which it can be reasoned—in the better production of the coal, as well as safety—machines should be used where undercutting by any other process is impossible. I am firmly convinced that every mining company would be better off, if, by law it was compulsory to mine the coal before shooting.

After installing machines, they should be given a thorough test by competent men, who will find out by a series of experiments the best way to mine and snub the coal—whether by powder or wedge—and the quantity of powder necessary for a given size of entry or room to properly bring down the coal, and then instruct the men as the machines are put on, for everything depends upon starting right, in mining, just as much as in everything else.

If the supervising officer who has charge of the men at the face sees that the miners obey the rules and instructions with reference to snubbing and shooting, I am sure that the use of machines will produce more economic results than when the coal is blasted without undercutting.

Educated Fingers

In "Joseph Dixon, World-Maker," Elbert Hubbard states that "in the Dixon Works the visitors are surprised and pleased to see scores of bright, healthy, active girls, who reach a hand into a box without looking, and pick out twelve pencils with one grab, ninety-nine times out of a hundred." Such practical efficiency, taught to girls at the Joseph Dixon Works, shoves modern efficiency talk off the desk into the waste basket.

"This digital skill seems to be a feminine attribute, for no man around the Dixon works can approach the women in efficiency."

Our office boy says he can do it if they are tied in bunches.

Taxation of Coal Lands

Present Methods of Assessment in the Anthracite Regions of Pennsylvania; Suggested Method Which is More Equitable

By R. V. Norris, E. M.*

THE proper method for the taxation of mineral land always will be a difficult problem, for its value is not readily ascertainable from sales and offerings, and many conditions may radically affect its true value.

The assessment of coal lands in the anthracite district of Pennsylvania is a good illustration of the difficulties inherent in attempting to arrive at a proper taxable value for such lands. Until 1907 the assessed valuations in this region, while irregular, and often unjust, were not so excessive as to create an unendurable burden on the industry and they were not seriously resisted. In 1907, there was, however, a general revision of the valuation, and the assessments were made so high that they were resisted in the courts, with the result that the taxes under this assessment are still in litigation, and appeals have been filed from all the later assessments, creating a condition of almost chaos.

The assessment of lands for taxation in Pennsylvania is made under Acts of the Legislatures of 1841 and 1842, in which the assessors are required to "assess, rate, and value every subject of taxation according to the actual value thereof, and at such rates and prices as the same would bring at a bona fide sale after due notice."

In actual assessment the four methods of taxation, attempted or suggested, have proved unsatisfactory and it is the purpose of this paper to point out their impracticability.

Valuation Based on Actual Sales. This method, which, under various decisions of the Supreme Court of Pennsylvania, is the only strictly legal one, has resulted in an almost hopeless tangle, as the testimony in the tax appeal cases shows. Sales have been made from a few hundred up to over $10,000 per acre for coal land, the smaller values usually for lands containing only relatively thin coal, medium values from $2,000 to $3,000 per acre for relatively small areas with normal coal contents, but unopened and not generally of sufficient area for separate operations, and excessive values in a few cases for going concerns, of lands strategically located, and thus having inflated values to particular purchasers.

Valuation Based on Foot-Acres of Coal.—It was early apparent that the mere sale values per superficial acre for scattered tracts could not properly be used as a criterion of value for lands containing widely different thicknesses of coal, and in the late '80's the assessment value was based on the foot-acreage of coal in the various holdings, generally in the form of an average blanket thickness, arrived at by the engineers of the operating companies, who returned under oath the average thickness of workable coal remaining unmined, calculated as spread equally over the area of each tract covered by the bottom bed.

This method, while more equitable than a valuation based on superficial acreage irrespective of coal thicknesses, is unjust in that it takes no cognizance of the varying thickness or qualities of the different beds of coal and the radically different cost of mining, and further is distinctly objected to by the Supreme Court of Pennsylvania, which says: (Pennsylvania Supreme Court Report No. 229, page 465, Reading Appeal) * * * *"that the foot-acre rule for ascertaining valuation of coal lands of the appellant for the purpose of taxation is not a proper measure of their value * * * *."

As an illustration of the extent to which the thickness and quality of coal influences its value, Fig. 1 shows the increased cost in cutting and loading only, due to decreased thickness in one particular colliery, this does not of course begin to show the total increased cost of mining in thinner beds, with the necessary greater development, more extensive haulage and ventilation, longer transportation, additional pumping, and greater cost of preparation; but it does indicate the irrationality of an assessment based on coal thickness irrespective of conditions.

The actual assessments per foot-acre, which under various subterfuges are still persisted in despite the law as interpreted by the Supreme Court of the state have gradually increased from about $50 to the 1913 assessment in Luzerne County, in the Wyoming field, where the assessed valuation was actually fixed at an equivalent present rate of $250 per foot-acre, about 20 cents per ton for all coal of all sizes estimated to be ultimately recoverable from the lands.

Assuming that the average rate of mining will exhaust all coal in 50 years, and that taxes must be paid on this valuation at the rate of but 20 mills, the present value per ton available in the ground on the basis of this monstrous assessment would be about $2.37, a figure many times greater than any possible value for mining purposes.

Valuations Based on Royalty Values. This method of valuation which has been advocated by many engineers, appears at first logical and proper; but it has been objected to by the Pennsylvania Supreme Court and hence cannot be legally used for assessment valuation. (Pennsylvania Supreme Court Report No. 229, page 470) which says, referring to royalty basis of valuation:

"Its market value is its fair selling value for cash, not payable as royalty strung out through a long series of years, but payable at the time or as soon thereafter as the

*Paper read before the American Mining Congress, Philadelphia, 1913.

value could be determined. Such a method does not make allowance in undeveloped territory for the length of time coal may lie in the ground unmined, undeveloped and unprofitable. It is impossible to reduce to a scientific basis and to mathematical precision the elements of value entering into the present selling price of a tract of coal land. The question is not what earning power coal lands may develop in the future, but what they are actually worth in the market at present."

Further, this method presents inherent difficulties and objections, paid during the mining of each tract of $30,000; on the basis of Luzerne County, Pa., 1913 assessment, these would each be valued at $400,000, and would pay approximately $8,000 annual taxes up to the average time of exhaustion. Their present values, on a royalty basis, calculated at 6 per cent. would be as follows:

Tracts	Start Mining Years	Complete Mining Years	Present Value Royalties	Less Present Value Taxes	Net Present Value
First		20	$344,100	$ 58,880	$285,220
Second	20	40	107,360	110,120	−12,760
Third	40	60	33,550	126,100	−92,550
Fourth	60	80	10,430	131,080	−120,650
Fifth	80	100	3,250	132,550	−129,300

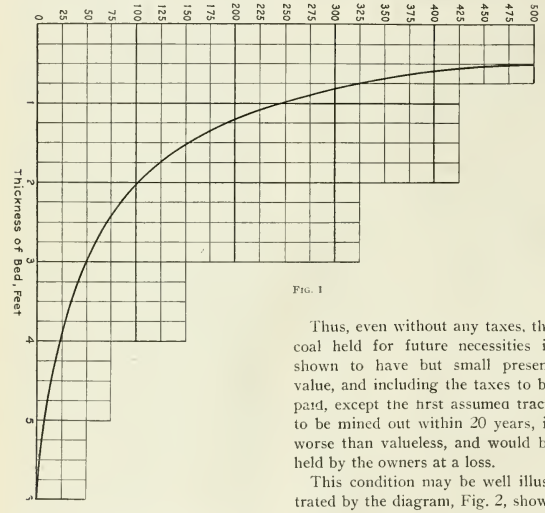


Fig. 1

which, remembering that under the Pennsylvania law assessment on similar properties must be equal, appears to be insuperable.

On a royalty basis of valuation, the time of mining is the controlling factor in calculating values. As an example, assume five exactly similar properties, each containing 2,000,000 tons of coal, to be worked out seriatim at an average of 100,000 tons per year, and each paying 30 cents per ton royalty, an annual royalty

Thus, even without any taxes, the coal held for future necessities is shown to have but small present value, and including the taxes to be paid, except the first assumed tract, to be mined out within 20 years, is worse than valueless, and would be held by the owners at a loss.

This condition may be well illustrated by the diagram, Fig. 2, showing the present values, and present value of tax charge on $100 to be paid at a future date, as on lands held for reserve. Hence, the Supreme Court is unquestionably justified in rejecting a royalty basis for assessment valuations; and taking the five example tracts above, it is apparent that, depending only on the element of time, the valuations on this basis vary from a value of $285,000 to a loss of $129,300, and it is greatly to the financial interest of the owners to have the properties exhausted in the shortest possible time, practically regardless of the ultimate yield; they are also financially justified in taking only the most available and most easily and quickly mined coal, even at the cost of the utter destruction of thinner beds which may be interstratified with the thicker ones, and which would be irretrievably ruined by the removal of larger beds below them.

Further, as a commentary on the justice and equality of an assessment based on royalty values, it is evident that a mere change of ownership, transferring a tract of coal land from a reserve for 50 years or more in the future under one ownership to coal immediately available to another, would radically change its assessed value. Also a valuation on present royalty rates may result in absolute tax confiscation of lands leased at the going rates of many years ago, in many of which leases the taxes were covenanted to be paid by the owners, as many anthracite leases made in the 60's and 70's of the last century pay from 8 to 25 cents per ton on the larger sizes only, while present royalties vary from 35 to 60 cents per ton for prepared sizes, with about half these prices for pea, and one-quarter for buckwheat coal.

Valuation Upon Capitalized Estimated Profits.—This method of valuation has been proposed but as far as is known has never been applied to the assessment of coal land in Pennsylvania; it has all the objections applying to royalty valuations, with the further serious objection that the profits of mining enterprises are, under similar conditions, largely dependent upon the management and such a basis for assessment would result in most unjustly penal-

izing good management, which essentially involves good and economical mining with resulting lower losses and the recovery of larger percentages of the mineral in the ground.

Conclusions.—It appears that none of the suggested or attempted methods of assessment has resulted, or can result, in an equitable valuation fair and just to both the public and the owners of coal land, that even moderate taxation of the coal in the ground is opposed to all principles of conservation, as its effect is to put a tremendous premium on rapid mining, almost regardless of ultimate recovery, to encourage the destruction of poorer and thinner beds interstratified with the better ones, on account of the enormous penalty entailed in slower mining, and to discourage by prohibitive penalties the holding of lands in reserve for the future necessities of the people.

For these reasons it appears that the taxation of mineral in the ground is logically and economically wrong, leading to the rapid and uneconomical exhaustion of the mineral wealth of the country, and putting a premium on premature and wasteful exploitation, and that the proper method of taxation for all minerals would be a tax based on the value at the mine of each year's product at the local rate of taxation assessed for that particular year, including an assessment on surface lands, outside improvements and machinery, the values of which are readily ascertainable, but not including any valuation of mine openings or inside improvements, which are incidental to the mining process and after exhaustion of the mineral are of no value.

Thus, a colliery producing 1,000,000 tons of anthracite in 1912, with a value at the mine of say $2,500,000, and with surface and improvements valued at $1,500,000, should pay taxes for the year 1913, on $4,000,000 valuation, regardless of the area of coal land tributary to such a colliery, and if for any cause the production in some later year should fall to $1,000,000 in value and the value of the surface and improvements decrease to $1,000,000 valuation, the taxes for the next year should be assessed on but $2,000,000 valuation.

This suggested method of assessment and taxation of coal lands is, of course, clearly illegal under the present laws of the state of Pennsylvania, and would require special legislation to put it in force, and while not absolutely just, in that it assesses coal from thin and impure beds, costly to mine, at the same rate as that from the more cheaply mined thick and pure beds, would, if legalized, possess the inestimable advantage of doing away with all uncertainty and litigation as to assessed valuations, result in the payment of taxes in greatest amount at the times of greatest production and consequent greatest population and public need for money; and by concentrating taxation on the land most actively worked and relieving reserve land from its present crushing burdens, would tend to the conservation instead of the dissipation of the irreplaceable coal resources of the country, by encouraging the complete mining of lands once opened including all workable beds large and small, rather than the opening of the best beds on all lands to obtain immediate returns and avoid the burdens of accumulating taxation, even at the cost of the destruction of smaller and less valuable beds lying above the larger ones.

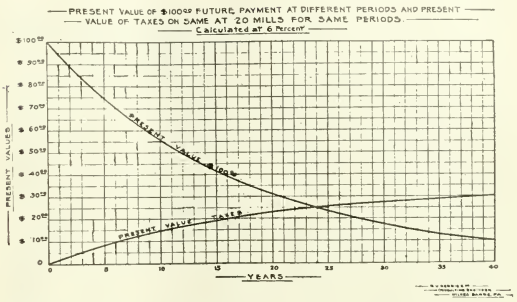


Fig 2.

D., L. & W. Coal Mining Department

At a dinner recently tendered the foremen of the Kingston Division of the Delaware, Lackawanna & Western Coal Mining Department, the subject of accidents was the topic of the evening.

In the absence of Mr. Phillips and Mr. Tobey, Mr. H. G. Davis, district superintendent, presided as toastmaster, and his greeting which follows was afterwards printed and sent to all employes of the company.

Coal Mining Department
Kingston Station, Pa.,
January 8, 1914
Safety First

Greeting:

To the foremen, and assistants, driver bosses, breaker bosses, company men, patrolmen, miners, and all other employes of the Coal Mining Department, D., L. & W. R. R. Co.

The making of New Year resolutions is an old custom. It occurred to me that if we could induce all of our employes to resolve at the beginning of the year 1914, to keep the words "Safety First" continually before them, that less fatal and nonfatal accidents would be the direct result, in and about our mines.

We, who are in direct charge of these mines, should resolve to do everything possible to prevent accidents by living up to the full intent and meaning of the company rules, regulations, and state laws,

Unless our employes resolve to cooperate with us and pledge themselves to use proper care in the performance of their duties, our efforts will not avail. They should study the hazards connected with their occupations, and report any defect, or danger found to exist, to the person for the time being in charge.

Discipline is the most important word in the English language today in its relation to coal mining. If any of our employes are unwilling to give their hearty cooperation by living up to our rules and the mine law they should voluntarily leave the service of the company. Any employe found guilty of violating the laws or rules intentionally should be dismissed from the service at once.

We particularly ask the Grievance Committees at our various mines to take up this important question at their local meetings and explain the same, and request each individual to do his part for "Safety First" for the year, 1914. Happy New Year to all! Sincerely,

District Superintendent

The zeal and loyalty with which the officials of this company work together is not to be surpassed by those of any company, and that accidents in their mines are not fewer is because of the exceedingly treacherous roof that is found in the northern anthracite coal field, and in addition the steep pitches in the southern end of the field, where the coal is folded and the same seam makes angles of 180 degrees in short distances. At the National colliery of this company, over 1,000,000 tons of coal were mined without an accident.

Through the kindness of Mr. Davis, we are enabled to furnish statistics relative to the wonderful output of the Truesdale breaker, only one-half of which is in operation. This breaker started to work in 1906 at a new mine, only developing, and which even at this date is not fully developed.

At the Woodward breaker of this same company, 1,012,329 tons were prepared for market in 1913.

Truesdale Mines, 1913

Number of days worked	283.4
Production, 1913, gross tons	1,125,510
Shipments, tons	1,089,510
Shipments by sizes, about, per cent	63
Largest daily output, tons	5,790
Average daily output, tons, per 9-hour day	3,844
Number openings, 7; 2 shafts; depth, 600 feet; 3 slopes; 2 tunnels.	
Number seams worked and size: George, 4 feet; Mills, 8 feet; Hillman, 7 feet; Cooper, 4 feet; Bennet, 3 feet; Forge, 4 feet; Twin, 3½ to 4 feet. Top Ross, 4 feet; Ross, 8 feet; Top Red Ash, 5 to 6 feet; Bottom Red Ash, 5 to 6 feet.	
Method of working, size of gangways, chambers, and pillars: Gangways, 7 ft.×12 ft.; chambers, 20 feet wide; pillars, 40 feet to 60 feet wide.	
Ventilation produced by 2 electric and 4 steam fans.	
Drainage by electric pumps.	
Haulage by mules and electric locomotives.	
Number of employes, 1,739.	

The Annual Safety Boosting Banquet

The United States Coal and Coke Co., subsidiary of the United States Steel Corporation, at Gary, W. Va., gave its fourth annual safety boosting banquet to its officials on January 10. There were 175 persons present, 150 of whom were foremen and officials of the company. The remainder were men of affairs in coal mining. Several interesting addresses were delivered by the various officials of the company, as well as by the visitors. Governor Hatfield, who was unable to be present, mailed his address to General Manager Edward O'Toole.

In his address, Governor Hatfield said: "I feel that I would be lacking in a sense of appreciation of services well done had I not taken advantage of this opportunity to extend to you my heartiest felicitations upon the unprecedented stride taken by the United States Coal Co.'s officials for the protection of human life. The day is past when it can longer be contended that precaution in the mining industry is impractical—that it is too expensive to look after the welfare of humanity; and to Mr. O'Toole and the other officials of the United States Coal and Coke Co., who are recognized as pioneers in the movement for the prevention of accidents in coal mines, the people of our state owe an everlasting debt. A perusal of reports shows me that you have an average tonnage of 476,454 for each fatality in the mines at Gary, your record standing out in sharp contrast to the general average in McDowell County, which shows the fatality tonnage to be 141,582. I know that some real work has been done to make such a remarkable record as this, and I trust that you will continue to strive to reduce the mining dangers to an actual minimum.

"I want to assure you my hearty interest in the continued success of the model mining operations at Gary, and nothing will be of greater pleasure to me than to give my cooperation to your plans for accident prevention."

A special feature of the banquet was the foremen's honor table at which were seated 17 foremen and assistants who have had a clear accident record for 6 months or longer, some as long as 26 months.

In order to give the officials an incentive to be constantly on the lookout for dangers which might be the cause of accidents, the company gives a premium to each of its foremen and assistants each month for a clear accident record. These men after having a clear record for 6 consecutive months receive a special premium of from $10 to $15 dollars per month, in addition to their regular premium. This premium system has been in practice since May, 1909, and is arranged on a merit and demerit basis, and since its adoption the company has paid 2,337 premiums, in all $15,875.

The Ohio coal mining commission appointed by Governor Cox, of Ohio, visited Gary during the period in which they were getting up their report, on page 24 of which they state "nowhere has this commission seen such elaborate and complete precautions taken to prevent accidents as are to be found in the mines of the United States Steel Corporation, at Gary, W. Va."

Acton, Alabama, Explosion

C. H. Nesbit, chief mine inspector of Alabama, who has recently completed his investigation of the disaster of November 18 in the Alabama Fuel and Iron Co.'s No. 2 mine at Acton, which caused the loss of 24 lives, reports that a blown-out shot caused several kegs of powder to explode, and this in turn led to the ignition of methane gas and coal dust.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Rope Lubrication

Editor The Colliery Engineer:

Sir:—If you have any records, facts, or figures obtained by scientific investigation or by some reliable, practical party or company, relative to rope lubrication, both hoisting and hauling, wet and dry conditions, will you please publish same or forward copy of data to my address.

A. H. P.

Information Wanted

Editor The Colliery Engineer:

Sir:—I have been taking your paper all this time since you have been sending it here in care of me for Mr. Lodge.

He was Capt. W. M. Lodge in the rebel army fighting for Madero, and it was reported by a man named Hudson that he was killed in a battle at Casa Grande, on March 6, 1911. That was reported in the San Francisco *Call* and we have heard nothing of him since. You may know of some mining men that knew him. Anything your readers hear or know we shall be delighted to hear of him.

W. J. Jackman

Terra Nova Mine, Baie Verte, Newfoundland

Effect on Roof of Dewatering a Flooded Mine

Editor The Colliery Engineer:

Sir:—In reply to your correspondent, "G. I. E." relative to flooded mine, I would say that it is not likely that any of the dangers cited by his friends will materialize. Under the conditions stated, to form a vacuum would be a physical impossibility. When the mine was flooded the lower or east workings would flood first and the west or rise portion would then begin to fill and immediately the water had risen to the roof of the seam on the west side the ventilation would be entirely cut off, leaving all rooms and entries full of air; as the water kept rising all of this air would be compressed and decrease in volume as the head of water increased, and this air still remains in the rise workings, so that immediately the process of pumping is started the air in the rise portion will simply increase in volume as the head of water is decreased.

Of course there is one element of danger which should be assumed to be present. I refer to the possible presence of marsh gas as a dangerous factor, and one which would be only possible in the rise workings. If such gas were given off, even in a very limited degree, the area which was originally an area containing air might now, as the result of the presence of marsh gas, contain a violently explosive mixture, and safety lamps would be necessary until the west portion of mine could be explored and ventilated.

One would rather that the depth of shaft had been stated, also the approximate area of west work, as by having such data a more accurate statement could be made. However, I trust the information here offered may aid "G. I. E."

Manus Glancy

Lovington, Ill.

Single-Motor vs. Two-Motor Types of Mine Locomotives

Editor The Colliery Engineer:

Sir:—Mr. Eric A. Lof's article in your December number on "Electric Haulage," cannot be passed without some comment. Mr. Lof makes two points in his comparison between single-motor and two-motor type of mine locomotives that should be corrected.

Firstly, regarding the hauling capacity, he states that actual tests have demonstrated that two-motor machines will pull 10 to 20 per cent. more than the single-motor mechanically connected machine. Mr. Lof has unquestionably got his figures reversed on this, as it is common knowledge that the single-motor mechanically connected locomotive will pull from 15 to 25 per cent. more than the two-motor non-mechanically connected locomotive. Not only is this of practical demonstration, but there is a very simple theoretical proof which has already appeared in your magazine. Several years ago I was visiting the Morley mine, of the Colorado Fuel and Iron Co., where they were using a 6-ton single-motor locomotive, and an 8-ton two-motor locomotive of another make. The mine foreman, Mr. Jenkins, expressed his surprise to me at the fact that the 6-ton single-motor locomotive would haul more coal than the 8-ton two-motor locomotive. It is furthermore, common talk among the motormen that a 10-ton single-motor locomotive will "haul anything they couple on to them," "yank the face out of the entries, etc."

Another point is regarding the overall width of a single-motor locomotive. The single-motor locomotive is almost invariably constructed with outside wheels, so that the overall width of the locomotive is absolutely no more than the width from outside to outside of wheel, this plainly being an absolute minimum width for any locomotive.

Another point of advantage of the single-motor locomotive is when coupled in tandem to form the so-called tandem type. Here the controller need handle only two motors, greatly simplifying the controller and the connections between the two locomotives.

Both the single-motor locomotive and the two-motor locomotive have their good points, and mining con-

ditions will often indicate either one or the other plainly, yet for certain service, the opinion of a great many prominent operators is that the single-motor locomotive is preferable to the two-motor locomotive, due to its compactness, and great hauling capacity, the two points which Mr. Lof denies in his article.

Benedict Shubart

Denver, Colo., Dec. 29, 1913.

Pillar Drawing

Editor The Colliery Engineer:

Sir:—I submit the following answer to question in relation to "Pillar Drawing" in the December Letter Box.

While there are hardly sufficient facts given in such a brief letter, there are a whole lot of facts or conditions in connection with such condition of mine. There is nothing to be gained by talking of what ought to have been done in the past, therefore, I will give you an opinion as brief as possible, from the two chief points in view: (1) The thick sandstone which you want broken. (2) To obtain the greatest amount of coal from the pillars.

Answer to (1): To work out as large an area of coal in as short a time as practical, I would take every alternate room for haulage. In retreating, turn off a lift (piece 5 yards wide) both to right and left, to cut out the pillars, then come back 5 yards, and go through in the same manner with another lift or slice 5 yards wide. I would advise the alternate-room method, where the track has to be relaid, to cut down the expenses; but where the cost wouldn't be abnormal, I should have the track in every room, thus I would get more men to work on the pillars. Take as many rooms as would cover a distance of from 400 feet to 800 feet, with as many men as can be handled to best advantage. This would be the factor from which to determine the number of rooms to work at one time. After each room pillar working had taken out its 5 yards lift, to right and left, the mine boss would need to be on the alert, to hold up some places and hurry up others, so that all would finish together. The next task would be to get out all the timbers in such worked-out part, in the shortest time, (and get everything out clean) this being the only method to break thick, strong sandstones; if they can be broken, it is only by breaking quickly. It may not be done the first or second time; we all know what mining consists of, especially in such cases as the present one, but by dogged perseverance, once you get the sandstone broken, with only half the care afterwards the same result will continue (such sandstones will bend like leather, which is a good property, when working by the longwall method).

Answer to (2): The chief feature to bear in mind, is that the weight of superincumbent strata comes from the rise. This is a fact easy to reason out, in the mind of any either purely practical, theoretical, or practical and theoretical miner. I can draw to my mind, instances where pillars have been taken out so clean, that some would hardly believe it possible to have such a small amount of coal lost; by leaving the goaf or gob to the dip, the dead work following was little or nothing, since the weight of top had a natural tendency to throw itself off the pillars into the goaf; on the other hand I can recollect that in the same mine, and at the same time, when taking out rise pillars, leaving the gob to the rise, the weight of top, coming from the rise, was the cause of much coal being lost by the top overriding the pillars. When we drew the timber in the worked-out part we did not wish to leave any coal, because when such coal was left it simply accelerated the trouble which was already great. The expense on the roads in such pillars was also great, and then greater difficulties while hauling the coal, since the roads were never so good as where we were leaving the gob to the dip (when leaving the gob to rise we were closing back on to the shaft pillars). My advice is therefore, (1) to break the sandstone quickly and cut out the bending action. (2) To leave the goaf to the dip, if at all possible, besides expenses, indirectly caused otherwise, will probably overbalance the cost of hauling to the rise, or from the dip.

Linton, Ind. W. H. Luxton

Fiber or Paper Air Pipes

Editor The Colliery Engineer:

Sir:—We have an inquiry from a German client relative to the use of fiber or pressed paper for air pipes. The client is under the impression that pipes of this description were used to convey air in a mine in the Pittsburg district. Can you furnish us any information relative to making use of such pipes?

National Association of Manufacturers

Foreign Department

In answer to inquiries to those in position to know, the Editor received the following replies:

Editor the Colliery Engineer:

Sir:—In reply to your letter of recent date relative to the use of fiber or pressed-paper pipes for conveying air in mines, would say, I have been in conference with Mr. Schallenberg and he does not know of the use of paper pipe as inquired about by you, but it occurred to me in the discussion that a few years ago I had seen, in the recovery of a mine after an explosion, ordinary roofing paper used for making a temporary brattice to convey the air. This, of course, was not in pipe form but simply rolls, and it was stretched along the entry and nailed to posts which were set up temporarily for this purpose. It is possible that this is what your correspondent has reference to.

Samuel A. Taylor

Editor The Colliery Engineer:

Sir:—Referring to fiber conduit used in mines, would state that our Pittsburg branch has advised us that they have sold this material to a number of coal mines in the vicinity of Pittsburg.

One interesting installation was at the mines of the Ellsworth Collieries Co., Ellsworth, Pa., where the pipe is used for running down the shaft and protecting electric cables. They have also sold some fiber pipe to mines for sulphur water. The pipe

is satisfactory so far as the action of the acid is concerned, but the trouble is that we cannot furnish large enough size and it will not stand great pressure. The pipe has been used where the head was sufficient to give an internal pressure of about 70 pounds, and this gave satisfactory results. So far as we can learn none has been used for air conduits.

H. W. Johns-Manville Co.

"Land" and the Common Law

Editor The Colliery Engineer:

Sir:—Seeing your editorial in the December number of The Colliery Engineer on the question of the "Anthracite Mine Cave Problem," and the criticisms thereon, reminds me that the criticisms are not in accord even with the old iron-clad and rugged rules of the common law of England upon which the foundations of our own laws are based.

In the common law, land, in its legal signification, had an indefinite extent upwards, so that by a conveyance of land, all buildings, growing timber, and water, erected and being thereupon, shall likewise pass. Not only had land in its legal signification an indefinite extent upwards, but in contemplation of the common law it extends downwards, so that whatever is in direct line between the surface of any land and the center of the earth belonged to the owner of the surface; and hence the word "land," which is *nomen generalissimum*, includes not only the face of the earth, but every thing under it or over it; and, therefore, if a man granted all his lands, he granted thereby all his mines, his woods, his waters, and his houses, as well as his fields and meadows.

It was a presumption of the common law that the owner of the freehold had a right to the mines and minerals underneath, yet even this presumption could have been rebutted by showing a distinct title to the surface and to that which was beneath; for mines may have formed a distinct possession and different inheritance; and, indeed it did frequently happen that a person being entitled to both the mines and to the land above, granted away the land, excepting out of the grant the mines, which would otherwise have passed under the conveyance of the land, and also reserving to himself the power of entering upon the surface of the land which he has granted away, in order to do such acts as may be necessary for the purpose of getting the minerals excepted out of the grant, a fair compensation being made to the grantee for so entering and working the mines. In this case it may be seen, one person had the land above, and the other the mines below, with the power of getting the minerals, and, therefore, the grantor was entitled to such mines only as he could work, leaving a reasonable support for the surface. And here it may be observed, that the bare exception of the mines and minerals, without a reservation of right of entry, would have vested in the grantor the whole of the mines and minerals; but he would have no right to work or get them except by the consent of the grantee, or by means of access through other shafts or adits, with which the grantee's land had nothing to do; because, in the case here put, the two properties, viz., the surface and the subterranean products, are totally distinct.

It will be noticed that this is very near the same as the decisions of the Supreme Court of Pennsylvania in a great many particulars. It will also be noticed that the statement, that "surface support is an inherent right of the purchaser," did not prevail even in the common law, as it will be seen that it also was a mere question of contract between the grantor and grantee, as it is now.

Strauss L. Lloyd
Chemist and Mining Engineer
Inverness, Florida

Haulage Problem

Editor The Colliery Engineer:

Sir:—Since the introduction of electrical haulage in this section, there has been considerable difficulty met with in working out a satisfactory system of distributing cars to the working places.

We use no mules at all, and have one 12-ton main line locomotive, and six 4-ton gathering locomotives.

Gathering locomotives run to the face of all working places, and bring their trips to side tracks on the main lines. The main entry is on the four-entry system and is in 3,000 feet; at 2,000 feet two short face entries are in about 200 feet.

Fifty feet from the drift mouth, a face entry turns off and is in 2,500 feet, and nine butt entries are turned off this face; butt entries are from 200 to 2,000 feet in.

Coal is 5 feet high, clean, with good bottom and top. Slate is only taken from one outcrop entry.

Coal is undercut by machines. All water is pumped out and track is kept in good condition. Average grade against haul is 3 per cent. Rooms are driven 250 feet long, and 30 feet in width.

Forty-pound steel is used on entries and 20-pound in rooms, and all 40-pound steel is bonded, while a cable is used in rooms with the 20-pound steel. We have one hundred and seventy-five cars of 2-ton capacity which are kept in good repair.

Side tracks are on all butt entries, also one main line between butt entries, capable of holding 20 to 25 cars each.

Tipple is only 300 feet from drift, with cross-over dump, tail, and run-around tracks. Average number of cars per trip for 12-ton locomotive is 25. For 4-ton gathering locomotive, 8. One hundred available working places are at hand.

I would like you or your readers to suggest some method of handling trips, etc., so as to get the largest possible output with the equipment we have.

Have we enough cars and motors to get an output of 500 cars, per 10-hour shift? How many cars and motors should we have? How many cars should we get with present equipment? Average miner can load from 6 to 8 cars per day.

I will greatly appreciate any discussion of this subject by you or your readers.

Mining Engineer

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

54. Why are suction fans more generally used at anthracite mines than blowing or pressure fans? Give the advantages and disadvantages of both systems, and when, in your judgment, would it be best to use a blowing and when a suction fan? Conditions being the same, which would produce the largest volume of air, suction or blowing fan?

55. What horsepower of engine will be required for circulating 100,000 cubic feet of air in two splits in a mine where the present circulation is 40,000 cubic feet in a single split and the water gauge is 1.75 inches?

56. Wishing to provide for a possible circulation of 200,000 cubic feet of air per minute under ordinary mining conditions, which fan would you adopt and why: a fan designed to throw 200,000 cubic feet of air against a 6-inch water gauge, or a fan designed to yield the same volume of air against a 2-inch water gauge?

57. With an airway 6 feet by 9 feet and 4,620 feet long and a current of air passing through it at 480 feet per minute, what would be the quantity of air passing in a minute, the pressure in pounds per square feet, the water gauge, and the horsepower?

Answers for Which Prizes Have Been Awarded

Ques. 46.—Suppose it requires 1 inch of water gauge to circulate 30,000 cubic feet of air per minute, and it is required to reduce this quantity to 25,000 cubic feet per minute by fixing a regulator. Find the area necessary for a regulator.

Ans.—Assuming other conditions remaining the same, the water gauge due to the passage of 25,000 cubic feet of air can be found by applying the following rule: The pressure varies directly as the square of the quantity.

$30{,}000^2 : 25{,}000^2 :: 1$ in. : x, equals, .694 inch water guage. The water gauge due to the regulator will then be, 1 in.—.694 or .306 inch. This is theoretically the reading of a water gauge placed on the regulator.

The area of the opening is calculated by the following formula:

$$a = .00038 \frac{q}{\sqrt{i}}$$

i being the difference in the water gauge of the two sides of the regulator.

Substituting the given values in the formula,

$$a = \frac{.00038 \times 25{,}000}{\sqrt{.306}} = 17.173 \text{ square feet.}$$

James E. Lamb

Bridgeville, Pa.

Second Prize, E. C. Lee, West Pittston, Pa.

Ques. 47.—What is the breaking strain of an oak beam, 6 feet long between the supports, 10 inches deep and 5 inches wide, with the load evenly distributed and both ends fixed? How much stronger is the beam than one of the same quality 7 feet between supports, 9 inches deep, and 6 inches wide, fixed in the same way, but with the weight in the center?

Ans.—Consider the $5'' \times 10''$ beam first. The maximum bending moment $= M = \frac{(w_1 + w_2)l}{12}$ for a beam with both ends fixed.

M also equals $\frac{s}{c} I = s \frac{I}{c}$ or sS; s = ultimate extreme fiber stress = 7,000 pounds per square inch; c = distance from neutral axis to extreme fiber = 5 inches = $\frac{d}{2}$; I = moment of inertia = $\frac{b\,d^3}{12}$; b = 5 inches; d = 10 inches; $l = 6 \times 12$ = 72 inches; w_1 = weight of beam; w_2 = load.

Oak weighs 46 pounds per cubic foot.

$$w_1 = \frac{10 \times 5}{144} \times 6 \times 46 = 95.83 \text{ pounds}$$

$$S = \frac{I}{c} \text{ or } \frac{b\,d^3}{12} \div \frac{d}{2} = \frac{b\,d^2}{6} = \frac{5 \times 10^2}{6} = 83.33$$

$$M = s\,S = 7{,}000 \times 83.33 = 583{,}333.33$$

But $M = \frac{(w_1 + w_2)l}{12}$

Therefore,

$$\frac{(w_1 + w_2)l}{12} = 583{,}333.33$$

Substituting for w_1 and l

$$\frac{(95.83+w_2)72}{12}=583,333.33$$

Clearing,

$$95.83+w_2=\frac{583,333.33}{6}=97,222.22$$

From which $w_2=(97,222.22+)-(95.83+)=97,126.39$ pounds, the load at which the 5″×10″ beam will break.

Next considering the 6″×9″ beam, the values, etc., are the same, except as follows:

$b=6$ inches; $d=9$ inches; $c=4.5$ inches; $l=7\times12=84$ inches; w_1 = weight of beam $=\frac{6\times9}{144}\times7\times46=120.25$ pounds; w_2 = load at center; $M=\frac{w_2 l}{8}+\frac{w_1 l}{12}$, and $M=s\,S$ also.

$$S=\frac{I}{c}=\frac{b\,d^3}{12}\div\frac{d}{2}=\frac{b\,d^2}{6}=\frac{6\times9^2}{6}=81;$$

$s=7,000$ pounds per square inch as before; $M=s\,S=7,000\times81=567,000$; $M=\frac{w_2 l}{8}+\frac{w_1 l}{12}=567,000$.

$\therefore 3\,w_2\times84+2\times120.25\times84=24\times567,000$; or $252\,w_2=13,608,000-20,202=13,587,798$; and $w_2=13,587,798\div252=53,919.8$ pounds.

Therefore, the 5″×10″ beam, 6 feet long, will carry $97,222.2-53,919.8=43,302.4$ pounds more than the 6″×9″ beam, 7 feet long, or it is 80.3 per cent. stronger.

In practice a factor of from 4 to 6 must be used to give what is termed "the safe load" in the beams.

Wm. J. Hallett

Rock Springs, Wyo.

Second Prize, M. R. Evans, Plymouth, Pa.

Ques. 48.—What size and description of pumps and equipment would you adopt to raise 400 gallons of water per minute from a depth of 1,000 feet?

Ans.—The size and description of pumps to be installed would be regulated to a great extent by the power available at the place of installation.

Assuming that the choice was our own and that there was an electrical supply at hand, then I would adopt electrically operated pumps.

The type of pump would also depend greatly on the conditions prevailing at the site of installation. Personally I would adopt a turbine pump which operates very successfully when run electrically.

This type of pump necessitates great care when installing. Provision must be made to free the incoming water from grit as much as possible as gritty water soon injures the impellers and vanes. A pump such as this operating against such a head would require to be multistage, but when properly installed would give satisfaction with very little attention as it is free from reciprocating parts.

Owing, however, to the difficulty encountered in most mines in freeing the water from grit I would adopt a ram pump of the three-throw Reidler type, which can be electrically driven by belt, ropes, or spur gear. I would adopt the rope drive owing to its flexibility.

The valves of this pump are operated mechanically and give satisfaction, especially when working under heavy loads of water, and enable the pump to be run at a much higher speed than the pump with ordinary valves.

I would calculate size as follows:

400 gallons per minute divided between 3 rams $=\frac{400}{3}=134$ for each ram. Then allowing 10 per cent. to 12 per cent. for slip, we have approximately 150 gallons per minute for each ram.

To find the size of ram (single acting) to pump 150 gallons per minute, we have

$$D=\sqrt{\frac{G}{.034\,L\,N}}\ (1)\quad\text{or}\quad D=\sqrt{\frac{G}{.034\,S}}\ (2)$$

Where D = diameter of ram;
G = gallons per minute;
L = length of stroke;
N = number of strokes;
S = revolutions per minute.

Then using No. 2 and substituting,

$$D=\sqrt{\frac{150}{.034\times80}}$$

Taking 80 as speed, a usual speed for this pump.

Ram = 7.5 inches, therefore we could have length of stroke = 14 inches.

Pump running 80 revolutions per minute.

Size of Pipes Required.—As in the case of ventilation, the pressure required to overcome friction varies as the square of the velocity. Pipes should therefore be of ample size to keep the velocity within reasonable limits and it should not exceed 200 feet per minute.

Therefore, as we have 400 gallons per minute and allowing 150 feet per minute we arrive at required size of pipe as follows:

Cubic feet of water per minute $=\frac{400}{6.25}=64$.

Area of pipes in square feet $=\frac{64}{150}=.43$.

Area of pipes in square inches $=144\times.43=79$.

Diameter of pipes $=\sqrt{\frac{79}{.7854}}=9$ inches.

I purposely took the velocity of water low so as to arrive at a large pipe, which is a good practice in view of an increase of water.

To find thickness of pipes required, Professor Galloway gives the formula, $T=.00017\,P\,D+.47$ inch.

Where,

T = thickness;
P = pressure;
D = diameter.

Therefore, thickness of pipes in this case will be

$T=.00017\times434\times9+.47$ inch, approximately 1.2 inches; say, $1\frac{1}{4}$ inches to allow for extra pressure.

This thickness of pipe need not be continued right up, as the pressure gets less.

Size of motor to drive this pump:

Work done in foot-pounds $=400+50$ to allow for friction $\times10\times1,000=4,500,000=\frac{4,500,000}{33,000}=136.5$ I. H. P., assuming a gallon of water to weigh 10 pounds.

Now assume the motor efficiency to be 85 per cent. and E. M. F. 500 volts. Then the E. H. P. of the motor $=\frac{100}{85}\times136.5=163.5$.

Amperes $=\frac{\text{watts}}{\text{volts}}$

Therefore, $\frac{163.5 \times 746}{500} = 244.$

Summing up we have: Reidler pump with 3 rams, 7½-inch diameter each, with 14-inch stroke, to run 80 revolutions per minute, rope driven, with electric motor of 163.5 E. H. P.; say 200 horsepower for good work.

Delivery pipes of cast iron 9 inches diameter, $1\frac{1}{4}$ inches thick.

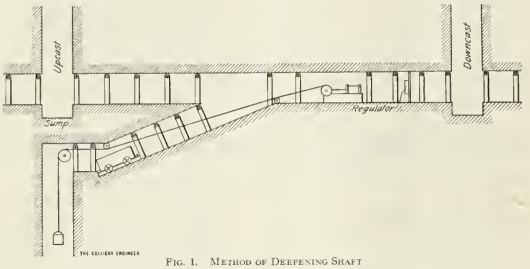


Fig. 1. Method of Deepening Shaft

Velocity of water in pipes 150 feet per minute.

In some cases this would be handled in stages, say one pump at bottom and another half-way up, but in my opinion the method I have adopted is best. Wm. McMahon

Taber, Alta., Can.

Second Prize, Lewis Jones, 42 R St., N. E., Washington, D. C.

Ques. 49.—Explain with sketches how you would deepen an upcast shaft without interfering with the hoisting of the coal, the work of sinking to proceed continuously.

Ans.—At a short distance from the shaft bottom and on the passageway between the downcast and upcast shafts, a steep slope should be driven, the angle of the slope depending on the amount of rock necessary for support under the old sump, Fig. 1. At the foot of the slope a level heading is driven to the opposite side of the shaft, the roof of the slope and heading being strongly timbered; extra strong timbers should be set in hitches cut in the sides directly under the sump before the work of excavating the shaft is commenced. The excavating is carried down in exact line with the shaft above, the material being removed from the shaft by a hoisting bucket operated by an electric hoist situated near the top of the slope. The hoisting rope should be so arranged that it can be detached from the hoisting bucket and attached to a car at the foot of the slope and hoisted to the top of the slope by the same hoist. A fresh supply of air from the downcast shaft could be conducted down one side of the slope and shaft and up the other by bratticing in the usual manner. When the sinking and timbering of the shaft is completed the sump above is drained and the two shafts connected either by driving upwards from a strong staging or sinking downwards from the sump.

John Barton

Midway, Pa.

Second Prize, Moses Johnson, Alberta, Can.

OBITUARY

WILLIAM STEIN

William Stein, of Shenandoah, Pa., former mine inspector in the anthracite region, died December 26, 1913. He was born in Scotland, November 15, 1838, and came to this country in 1872 and located at Shenandoah. Mr. Stein entered the mines at 8 years of age, but by studying nights obtained a fair degree of knowledge. Having accumulated a little money after reaching his majority he took a course of mining engineering with George Simpson, of Glasgow, as preceptor. After reaching Shenandoah he worked 3 years as a miner in the Plank Ridge, next was assistant inside foreman, at Kehley Run, and then held the same position at the Hammond colliery. In 1885 he was appointed mine inspector of the Sixth Anthracite District which comprised 41 collieries.

JOHN SKEATH

John Skeath, a prominent coal mining man in the anthracite region of Pennsylvania, died at the Fountain Springs State Hospital, near Ashland, Pa., on December 29, 1913.

Mr. Skeath would have attained his seventieth birthday next February. In a comparatively brief time, he rose from a slate picker to District Superintendent of the Philadelphia & Reading Coal and Iron Co.'s operations in the Mahanoy district, which position he held to within a few years ago.

Notes on Mines and Mining

By Special Correspondents

Henry F. Allen, of Pittsburg, representing capitalists in that city, has leased the building at First and Main Sts., Evansville, Ind., and will make it headquarters for his project to merge some fifteen or twenty of the largest coal mines in western Kentucky. The project involves several millions investment. With the building of locks and dams along the lower Ohio River and the opening of the Panama Canal, the capitalists associated with Mr. Allen believe western Kentucky will become one of the most important fields in the West.

ILLINOIS

J. W. Lowe, H. N. Taylor, and T. C. Keller, appointed appraisers of the properties of the O'Gara Coal Co., visited the mines of the company in Salina County, Ill., recently. One of them, who is acquainted with mining conditions all over the West, remarks that he never saw such perfect mining conditions as at these Saline County mines. He said he saw rooms that had been standing idle for a year and there was absolutely no fall of slate or roof. In some other districts the roofs in the mines have to be carefully inspected daily, and

falls are frequent. The appraisers will in the near future visit the mines of the related O'Gara properties in other states on a similar mission.

The Henrietta coal mine at Edwardsville, Ill., has been sold at a nominal figure to Mrs. Philipena Kraft, of East St. Louis. The mine was sunk in 1898 at a cost of about $70,000, and has recently been unsuccessful.

KANSAS

Prof. Erasmus Haworth, State Geologist of Kansas, does not concur in statements recently made by coal operators of that state, that the coal supply of Kansas will be exhausted in 20 years. He says the coal in Cherokee and Crawford counties will last at the present rate of mining for 200 years.

MICHIGAN

The Jackson Coal Co., which was organized not long ago at Jackson, Mich., to develop coal deposits near the town of Albion, has begun shipping on a small scale. The company has 500 acres under lease, 80 acres of which has been proved up and found to contain seams ranging in thickness from 3 to 4.5 feet, lying at depths of from 80 to 100 feet. The coal is said to be similar to that mined in the Saginaw Valley.

NORTH CAROLINA

But one mine produced coal in North Carolina in 1912, that of A. J. Jones, of Glendon, N. C. E. D. Steele, of High Point, and John L. Tull, of Hemp, own mines, but there was no production from them during the year.

OHIO

Coal operators along the Ohio River in the Pittsburg No. 8 and Pomeroy Bend fields, have been notified that the army engineers recommend an appropriation of $9,000,000 for the improvement of the Ohio River, which will probably be included in the Rivers and Harbors Bill in the United States Congress. This will mean a continuation of the former policy of furnishing a 9-foot stage at all seasons of the year.

34-7—6

State Mine Inspector, J. C. Davis, of Ohio, with several deputies, has opened mine No. 7 at Murray City, Ohio, which was sealed up last March to check a disastrous fire. It was found that the fire was out and the mine will be placed in operation soon.

PENNSYLVANIA

The annual meeting of the Employes' Relief Association of the "River Coal" Co., was held in Pittsburg, December 11, followed by the customary dinner in the evening. In the annual report submitted by the treasurer it was pointed out that total receipts from December 1, 1912, to November 30, 1913, were $78,783, and total disbursements $62,576, leaving a cash balance of $16,207 for the term.

John H. Jones, president of the Pittsburg-Buffalo Company, writes that while receivers have been appointed for that company, the Four States Coal and Coke Co., the Johnetta Coal Co., and the White Rock Supply Co., the following companies have not been placed in the hands of a receiver: United States Sewer Pipe Co., Johnetta Foundry and Machine Co., Johnetta Amusement Co., Allnite Coal and Lumber Co., Rayland Coal Co., Marianna Water Co., Marianna Light, Heat and Power Co., Johnetta Oil Co., Johnetta Gas Co., and the Pittsburg and Buffalo Co., of Cleveland.

The Buckeye Coal Co., a subsidiary of the Youngstown Sheet and Tube Co., Youngstown, Ohio, will develop the 5,000 acres of coal in Greene County, Pa., recently purchased from J. V. Thompson.

L. S. Mellinger, of Dawson, Pa., was recently named receiver for the Minerd & Herd Coal Co., which operates a custom mine at Wheeler, Pa. The company is composed of Charles Minerd and Washington Herd.

TENNESSEE

The purchase and development of 17,000 acres of coal and mineral lands in the vicinity of Spring City, Tenn., on the Cincinnati Southern Railroad, the construction of steel mills, coke ovens, by-product plants, the establishment of gas and electrical companies, are said to be among the plans of a foreign syndicate being promoted by Col. George Wilkinson, of Philadelphia, representing the interests of the International Bankers Alliance of London and Paris. It is understood the developments will cover $3,000,000. Up to the present, options have been secured on 17,000 acres in the Spring City vicinity.

VIRGINIA

On petition of Stephen H. Tallman, of New Jersey, Judge Scott of the Henrico, Va., circuit court named H. T. Lemist receiver for the Old Dominion Development Co., which operates several coal mines in Henrico, Va. Mr. Lemist is manager of the company. The court proceedings were by mutual consent of parties concerned.

WEST VIRGINIA

Coal Boll Coal Co., organized by Senator William Flinn, M. L. Benedum, J. C. Tress, Ralph Flinn, and M. H. Laughlin, of Pittsburg, and S. M. Dunbar, of West Virginia, will develop six mines on Open Fork of Bell Creek in Clay and Nicholas counties, W. Va. The operation comprises about 6,000 acres.

The Consolidation Coal Co., has put up new houses at Viropa, Glen Falls, and Lost Creek, W. Va., and F. R. Lyon, general manager of operations for the company, stated recently that the erection of new houses at other points was planned. None of these houses will cost less than $1,000 and the cost of many will run as high as $1,500.

It has been announced that a firm to be known as the Ohio Valley Co., will shortly install an electric power plant at Logan, W. Va. Power lines will be laid over the entire Logan coal field, and will be run up and down the Guyan River, Main Island Creek, Buffalo and Dingess runs. The plant will ultimately be of 30,000-kilowatt capacity composed of turbine units of 5,000 kilowatts each. It is expected that work will be started upon this plant within 3 weeks.

Answers to Examination Questions

Questions Selected from Those Asked at an Examination for Underground Manager held in Nova Scotia in 1913.

Ques. 1.—Explain the method you would adopt to find the position on the surface of the face of a level in the mine.

Ans.—It is assumed that a compass is used for making the necessary survey. Set up on the level at any convenient distance from the foot of the shaft and measure the bearing and distance from this point to one of the shaft guides. Then place a tack or other convenient mark in the tie which is in the track at the first bend in the level, and measure the bearing and distance from the compass to this tack. Next, set up on the tack and measure the bearing and distance to another tack placed in the tie at the second bend. These measurements are repeated at each turn in the level until a point is reached from which the face is visible, when the bearing and distance of its center from the last tack are measured. As an illustration, the recorded bearings and distances might be: From Station 1 to center of shaft, N 45° E, 22.50 feet; Station 1 to Station 2, S 45° W, 218.00 feet; Station 2 to Station 3, S 38° W, 411.00 feet; Station 3 to Station 4, S 40° W, 296.50 feet; and Station 4 to center of face, S 50° W, 195 feet.

Next, on the surface, set up the compass at such a point that the bearing and distance from it to the shaft guide is N 45° E, 22.50, which is the bearing and distance from Station 1 to the same guide as measured underground. This determines Station 1 on the surface directly over Station 1 in the mine. At the outset, an approximate location of Station 1 on the surface is made, and a more exact location then determined by shifting the tripod carrying the compass to the right or left until the bearing and distance from it to the guide are N 45° E, 22.50 feet. Mark this point with a stake, direct the compass to a bearing of S 45° W (bearing from underground Station 1 to underground Station 2) and on this bearing and 218 feet from Station 1, drive a stake which will be Station 2, immediately over Station 2 in the mine. From Station 2, place Station

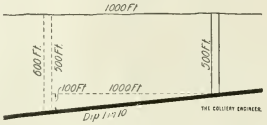


Fig. 1

3, and from Station 3, set Station 4, and similarly, the bearing and distance from the last station being that used to determine in the mine the bearing and distance from the last station to the face. The stake last placed on the surface is now directly over the face of the level in the mine.

It must be remembered that the compass is not at all accurate, as its needle is easily deflected from its true course by iron or steel rails, pipes, etc., always found in mines. It will be apparent that this deflection is commonly greater underground than on the surface, so that a bearing read in the mine and correctly laid out on the surface (where there is no disturbing influence) as S 45° W, may have been (had the needle in the mine not been deflected by rails, pipes, etc.) in reality, S 42° W. Thus, it is common for lines traced on the surface to gradually bend away from the lines they are assumed to be following underground, until at a distance of say 1,000 feet, it would be unusual to find the point on the surface within 10 feet, either way, of its exact location immediately over the point in the mine.

If the surface location of the face of the level is needed as the basis for determining the sinking of a shaft, bore hole, or any costly work, the shaft should be plumbed and all the operations performed with a transit handled by one skilled in such work.

Ques. 2.—If a certain coal shaft is 500 feet deep from the surface to the coal seam, and the coal seam is pitching 1 in 10, what would be the depth of a shaft sunk to this seam, at a point measuring 1,000 feet on the surface, from the first shaft and in line with the dip of the seam?

Ans.—A cross-section through the two shafts is shown in Fig. 1, in which the surface between the two is assumed to be level. Since the dip is 1 in 10, the bottom of the second shaft will be $1{,}000 \div 10 = 100$ feet below the bottom of the first shaft. As the first shaft is 500 feet to the coal, the second shaft will be $500 + 100 = 600$ feet deep at the point where it strikes the same seam.

Ques. 3.—How would you proceed to find the difference in level between two points on a haulageway separated by a distance of 500 feet? Neither point can be seen from the other.

Ans.—If the difference in level is to be made the basis of some important work, it should be determined accurately by means of a regulation leveling instrument. However, the underground manager with appliances ordinarily at hand can determine the difference in level between two points visible from a third point with a very high degree of

accuracy. Theoretically, the results are as perfect as obtainable through the use of the most perfect leveling instrument; the actual results are in proportion to the care used.

Assume that there is a bend in the level from which the two points are visible. Set up the compass tripod at this point, and on top of it place a carpenter's level in good adjustment. If a tripod is not to be had, rig up any kind of a firm support about 4 feet high. Make the tripod or support perfectly level and sight across the top of the carpenter's level to a plank held on the first point. Make a mark on this plank where the level line of sight comes. Take the plank to the second point and again mark on it the point where the level line comes. The difference between the first and second marks is the difference in level between the two points. If there are two bends in the level, there must be two set-ups made. Thus, the difference in elevation between point 1 and point 2 is found as described, and in exactly the same way is found the difference in elevation between point 2 and point 3, and the sum of the differences gives the difference in level between point 1 and point 3. If there are more than 2 bends, a set-up will have to be made between each of them. The differences in level are to be added algebraically, that is those indicating a rise are positive and marked with a + sign, and those noting a fall are negative and marked with a − sign. If the final sum has a minus sign, the last point is lower than the first; if it has a plus sign, the last point is the higher.

Ques. 4.—What is the area in square feet of a triangle whose base is 60 feet and the sides 50 feet each?

Ans.—This is an isosceles triangle, as it has two equal sides, $A\,B$ and $A\,C$, Fig. 2. Hence the perpendicular $A\,D$ divides the base into two equal parts, each of 30 feet. We have then to find the sum of the areas of two right-angled triangles of the same dimensions, in each of which the hypotenuse is 50 feet and one side 30 feet. The length of the remaining side, $A\,D$, which is common to each, is equal to $\sqrt{50^2-30^2}=\sqrt{1,600}=40$ feet. Hence the area of the triangle $A\,B\,C=2\times$area triangle $A\,B\,D=2\times\left(\frac{30\times40}{2}\right)=1,200$ square feet.

Ques. 5.—In a heading going S 45° E, what must be the course of a

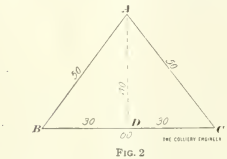


Fig. 2

cross-place going at right angles on the north side?

Ans.—While there are rules for determining the angle made by two lines having given bearings, or for finding the bearing of a line when the angle it makes with another line of known bearing is given, problems like the above are best solved by making a sketch of the workings as in Fig. 3. In the figure, the line $N\,S$ is the meridian, $O\,H$ is the heading, and $O\,C$ is a line parallel to the cross-place. It is apparent that the cross-place runs toward the northeast, and from the principles of geometry, its angle with the meridian must be 45

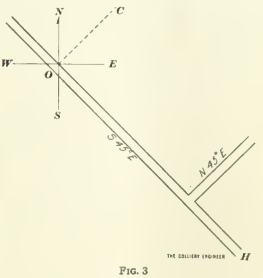


Fig. 3

degrees the same as that made by the heading, and, consequently, its bearing is N 45° E. But the angle made may be figured as follows: The angle $S\,O\,H=45$ degrees, the angle $H\,O\,C=90$ degrees (both from the terms of the problem), and since the sum of all the angles on one side of a straight line made by intersecting lines is 180 degrees, we have bearing of cross-place = angle $N\,O\,C=180°-$ angle $S\,O\,C=180°-(S\,O\,H+H\,O\,C)=180°-(45°+90°)=180°-135°=45°$, or bearing is N 45° E.

Ques. 6.—How would you make an allowance in measuring steep places, and why should any allowance be made?

Ans.—In measuring distances up or down a slope one of two methods may be used depending upon the instruments at hand. If a transit with a vertical circle is to be had, the distance between stations may be measured along the slope, the vertical angle the ground makes with the horizontal may be measured with the vertical circle and the slope distance (as measured) may be reduced to the horizontal distance by multiplying it by the cosine of the vertical angle. If a transit is not to be had, one end of the tape or chain is held at the first station or held over it, the exact point being determined by plumbing down with a bob. As much of the tape as can be kept level is stretched out in the direction of the line to be measured, and the end of the level line is marked on the surface at the point where the level tape meets it if the line is going up hill; or if the line is going down hill, the end of the level portion is carried down to and marked on the surface by dropping a plumb-line from its end. The tape is moved ahead and the process is repeated until the end of the line is reached, when the sum of the individual distances is equal to the total distance between the two points.

All measured distances are reduced to horizontal ones that they may appear in their true, relative length, when placed upon the map, which is a horizontal projection, on a small scale, of the mine and its workings.

Ques. 7.—Plat the following by scale and protractor, and give the closing distance and course from G to A. (Here follow six courses and distances from A to G.)

Ans.—It is not necessary to reproduce the map. Two methods are generally available for the purpose. Lay off a meridian at the extreme left hand or west corner of the property. Lay the protractor upon the meridian

and mark upon the paper points indicating all the courses which are to the east. Then reverse the protractor and as before mark all the courses which are to the west. At each point should be written the bearing of the course so that there may be no error from using the wrong one. From the point on the meridian used to center the protractor (which is station A) draw a line through the point used to mark the course $A\,B$ and on it lay off the distance $A\,B$ according to the scale selected. This locates the second station B and the first side $A\,B$. By means of a parallel ruler or by shifting with triangles convey from the meridian the bearing of the line $B\,C$ as laid off by the protractor, draw it through B and on it lay off the distance $B\,C$. This gives the second side $B\,C$ and the third corner C. Continue this until the seventh corner G is reached. The line $G\,A$ closes the survey and its bearing and length are wanted. The length may be found by means of the scale used to lay off the map, and the true length of the line is equal to the scaled length multiplied by the scale ratio. Thus, if the scale was 100 feet to the inch, and distance on the map measured 4.25 inches, the true distance would be $4.25\times100=425$ feet. The bearing of the line $G\,A$ may be found by placing the protractor on the meridian with its center over A (A being the starting point used in laying off the various bearings) and measuring the angle made by the line $G\,A$ with the meridian, which angle, with the proper letters, is the required bearing.

By the second method a meridian is drawn through each station as it in turn is located, and from this meridian is turned off the bearing of the next line only. That is, a meridian is laid off through A to locate $A\,B$, another through B to locate $B\,C$, a third through C to locate $C\,D$, and similarly.

By another method but one meridian is used, that through A, which is used solely to determine the direction of the first side $A\,B$. The line $A\,B$ is prolonged beyond B and used as a base for the protractor, which is centered over B, in laying off the angle between the sides $A\,B$ and $B\,C$ as determined from the difference in their bearings. All the other sides are laid off by means of these exterior angles, but the bearing and distance of the last side $G\,A$ is determined as noted above.

One of these methods is as accurate as the other, but as the protractor may slip or a distance be wrongly laid off, such an error affecting all the work laid off after it, it is better practice in making maps of any importance to calculate the latitudes and departures of all the stations and plot by means of coordinates.

Ques. 8.—Commencing at the southwest corner of a lot of land and running a line 1,720 feet north, thence east 2,650 feet, what will be the length of the remaining side of the lot and what are the contents of the lot in acres?

Ans.—It is apparent that the lot is in the form of a right-angled triangle, and that the remaining side is the hypotenuse. Since the hypotenuse is equal to the square root of the sum of the squares of the other two sides, we have, remaining side $=\sqrt{1{,}720^2+2{,}650^2}=\sqrt{9{,}980{,}900}=3{,}159.25$ feet.

Since the area of a right-angled triangle is equal to one-half that of a rectangle with sides of the same length, we have its area to be $\frac{1{,}720\times2{,}650}{2}=2{,}279{,}000$ square feet, or $2{,}279{,}000\div43{,}560=52.31$ acres.

Ques. 9.—In finding the velocity of the air-current in a mine with the anemometer, the index number before commencing was found to be 1,278,684, and after the instrument has been held 13 minutes in the current, the indicated number was 1,291,372. The instrument used requires an addition of 25 per 1,000 to the net reading. What then under the given conditions was the velocity of the current, in feet per minute?

Ans.—The total velocity of the air as recorded by the instrument is $1{,}291{,}372-1{,}278{,}684=12{,}688$ feet. Expressed in thousands of feet, this is 12.688. Since each 1,000 feet requires an addition of 25 feet to the net reading, the total addition to be made will be $12.688\times25=317.20$. This makes the true velocity of the current $12{,}688+317=13{,}005$ feet in 13 minutes, or $13{,}005\div13=1{,}000$ feet in 1 minute.

Ques. 10.—With 2 horsepower we have 10,000 cubic feet of air per minute in an airway 10 ft.$\times$10 ft., 3,000 feet long. How many horsepower will be required to circulate the same amount of air in an airway 5 ft.$\times$5 ft., having the same length?

Ans.—Using capital letters to indicate the dimensions, etc., of the larger airway and lower-case letters for the smaller airway, we have the formula for the power in the 10 ft.$\times$10 ft. airway to be $U=\frac{K\,L\,O\,Q^3}{A^3}$, and in the smaller airway, $u=\frac{k\,l\,o\,q^3}{a^3}$. The ratio of the powers is $\frac{u}{U}=\frac{k\,l\,o\,q^3}{a^3}\div\frac{K\,L\,O\,Q^3}{A^3}=\frac{A^3k\,l\,o\,q^3}{a^3KLOQ^3}=\frac{A^3o}{a^3O}$, since K and k (the coefficient of friction), L and l (the lengths), and Q and q (the quantities) are the same in each case. From this we have $u=$horsepower in smaller airway $=U\times\frac{A^3o}{a^3O}=2\times\frac{100^3\times20}{25^3\times40}=64$ horsepower. The other letters used, are A and a for the larger and smaller areas, respectively, $10\times10=100$ square feet and $5\times5=25$ square feet, and o and O for the smaller and larger perimeters, respectively, equal to $2\,(5+5)=20$ feet, and $2\,(10+10)=40$ feet. U is the horsepower necessary to circulate the air through the larger airway.

Ques. 11.—If 5 horsepower passes 35,000 cubic feet per minute, find the horsepower required to pass 70,000 cubic feet per minute?

Ans.—Referring to the formula used in the solution of Ques. 10, it is apparent since the coefficient of friction k, and the length, area, and perimeter are the same in each case, they may be dropped from the discussion and $\frac{u}{U}=\frac{q^3}{Q^3}$, whence $U=u\times\frac{Q^3}{q^3}=5\times\frac{70{,}000^3}{35{,}000^3}=5\times\frac{2^3}{1^3}=5\times8=40$ horsepower.

Ques. 12.—A fan making 50 revolutions per minute passes 18,000 cubic

feet of air. What quantity will pass with the fan speed increased to 80 revolutions?

Ans.—Theoretically, the quantity of air circulated is proportional to the number of revolutions of the fan. In the case in question, the amount of air at 80 revolutions per minute is $18{,}000 \times \frac{80}{50} = 28{,}800$ cubic feet.

In practice, however, the quantity circulated at the increased speed is more nearly in proportion to the fifth root of the fourth power of the revolutions per minute, or at 80 revolutions per minute, $Q = 18{,}000 \times \sqrt[5]{\left(\frac{80}{50}\right)^4} = 18{,}000 \times 1.4564 = 26{,}215$ cubic feet.

Ques. 13.—In a road where the inclination is 1 in 7, a fault of 30 feet down is met with. What is the shortest length of level stone drift necessary to gain the coal?

Ans.—In Fig. 4, let $O\,A$ represent the seam to the right of the fault, and $B\,C$ the seam after faulting. It is required to find the length of a level stone drift, $A\,C$, necessary to recover the coal. It must be assumed, in the absence of a statement to the contrary, that the fault plane is vertical (which is unusual) and consequently that the angle $B\,A\,C = 90$ degrees. Since the rise of the seam is 1 in 7, in the triangle $A\,B\,C$, the ratio of the sides is $A\,C : A\,B = 7 : 1$, because $A\,C$ is the horizontal distance (7) and $A\,B$ is the rise (1). Substituting for $A\,B$ its value of 30 feet, we have $A\,C : 30 = 7 : 1$, whence $A\,C$ = length of stone drift = $7 \times 30 = 210$ feet.

Ques. 14.—Divide $110 among four men and three boys, giving to each boy 50 per cent. of a man's share.

Ans.—Since each boy receives 50 per cent. or one-half of a man's share, 3 boys will receive as much as $3 \times .50$, or $(3 \times \frac{1}{2}) = 1.5$ men. The money is then distributed as if divided between 4 + 1.5 = 5.5 men, each of whom would receive $110 \div 5.5 = \$20$. But the boys get $\frac{1}{2}$ as much as the men, or $10 each. Hence four men receive $20 each, or a total of $80, and the 3 boys receive $10 each or a total of $30; the sum of which is $110.

Ques. 15.—A miner receives 15 per cent. of his monthly wages for timbering and 10 per cent. for water, and the remainder, $60 for coal cutting. Find his total wages.

Ans.—Since 15 + 10 = 25 per cent. of the miner's wages are paid for

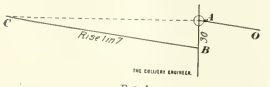


Fig. 4

timbering and water, 100 − 25 = 75 per cent. are paid for cutting coal. But this 75 per cent. amounts to $60, hence, 1 per cent. of his wages would be $60 ÷ 75 = $.80, and 100 per cent., which represents his entire wages, would be $.80 × 100 = $80.

This may also be figured by common fractions as follows: Since 25 per cent. is the same as $\frac{1}{4}$, $1 - \frac{1}{4} = \frac{3}{4}$ of his wages are paid for cutting coal. Now, if $\frac{3}{4}$ of his wages come to $60, $\frac{1}{4}$ will be equal to $60 ÷ 3 = $20, and $\frac{4}{4}$, or all his wages, will be equal to $20 × 4 = $80, as before.

Ques. 16.—A tunnel is 375 feet long, 7 feet high, and 7 feet wide at the top and 9 feet at the bottom. At $12 per linear yard, what would be the cost per cubic yard in the solid? How many boxes containing 15 cubic feet each would be filled, assuming the proportion of solid to broken to be as 55 is to 114?

Ans.—(*a*) The tunnel is 375 ÷ 3 = 125 yards long and will cost at $12 per yard, 125 × 12 = $1,500.

(*b*) The average width of the tunnel is $\frac{7+9}{2} = 8$ feet, and its area is 8 × 7 = 56 square feet. The volume of rock to be taken out is, thence, $\frac{375 \times 56}{27} = 777.78$ cubic yards. At a total cost of $1,500, the cost per cubic yard will be $1,500 ÷ 777.78 = $1.93, very nearly.

(*c*) 777.78 cubic yards are 777.78 × 27 = 21,000 cubic feet. This would fill 21,000 ÷ 15 = 1,400 boxes if loaded solid. But in mining the rock is broken so that 55 cubic feet of solid will require 114 cubic feet when broken, and the number of boxes necessary to hold it will be increased in the same proportion. Hence, $1{,}400 \times \frac{114}{55} = 2{,}902$ boxes, very nearly.

Ques. 17.—Find the depth of a cylindrical cistern containing 4,712.4 cubic feet, the diameter of the cistern being 20 feet.

Ans.—The formula for the volume of a cylinder is Vol. = area of base × height (or depth), from which, depth $= \frac{\text{volume}}{\text{area of base}} = \frac{4{,}712.4}{.7854 \times 10^2} = \frac{4{,}712.40}{314.16} = 15$ feet.

Ques. 18.—What is the cost of driving a place 4 ft. × 12 ft., 700 feet long, at 82 cents per cubic yard, to be timbered with timbers 2½-foot centers at 40 cents per set? Divide the total cost of driving the place between A, B, C, and D; A working 25 days, B 23 days, C 21 days, and D 19 days.

Ans.—The number of cubic yards is $\frac{700 \times (4 \times 12)}{27} = 1{,}244.44$; and the cost at $.82 per cubic yard is 1,244.44 × $.82 = $1,020.44.

The number of sets of timbers is (700 ÷ 2.5) + 1 = 281, which, at 40 cents per set, will cost $112.40. The entire cost of the tunnel will be $1,020.44 + 112.40 = $1,132.84.

The money will be divided in the ratio that the number of days each man worked bears to the number of days all of them worked, whence

A received $\frac{25}{88} \times 1{,}132.84 =$		$321.83
B received $\frac{23}{88} \times 1{,}132.84 =$		$296.08
C received $\frac{21}{88} \times 1{,}132.84 =$		$270.34
D received $\frac{19}{88} \times 1{,}132.84 =$		$244.59
		$1,132.84

Ques. 19.—What is the total pressure at the bottom of a pipe full of water, 10 inches in diameter, 800 feet high?

Ans.—The area of the bottom of the pipe is $.7854 \times 10^2 = 78.54$ square inches. Since the weight of a column of water 1 foot high and 1 square inch in area is .434 pound, the total pressure on the bottom of the pipe is 78.54 × 800 × .434 = 27,269.08 pounds.

Mine Ventilation

Method and Materials for Constructing Stoppings—Legal Requirements of Different States

Written for The Colliery Engineer (Continued from January)

STOPPINGS as they are preferably called, though almost always known in the United States as brattices, are built of some one of the many forms of masonry construction. Stone, set in mortar, like the foundation wall of a house, was at one time employed for the purpose but is no longer used owing to its high cost and is no better than many cheaper forms of construction. At one time it was a common practice to build stoppings of flat pieces of draw slate gathered up in the workings. These were built up in a double dry wall, the space between them being filled with road cleanings, slack, and any fine material, and the joints plastered with ordinary lime mortar. The use of fine coal should be prohibited for this purpose, for it is apparent that in event of an explosion of any magnitude, each brattice destroyed would mean the throwing into the air of a large amount of fine coal which would add to the force of the explosion through its burning. If stoppings are built of roof slate, they should be a single wall laid in cement mortar and with no dust. Brick stoppings are very satisfactory and are cheaply built. They are commonly one brick, or 9 inches thick, the brick being laid in a cement mortar composed of one part of Portland cement to two parts of sharp sand. Another material for brattices is hollow tile made of clay, baked, which may be had of almost any dimensions. For a wall 9 inches thick, the tile (or blocks as they are frequently called), may be 9 inches thick, 6 inches to 9 inches high, and 12 inches to 16 inches in length. These, again, are laid in cement mortar of the composition stated above. In the case of the brattices made up of individual slabs of slate, brick, or tile, some builders coat them with a layer from ½ inch to 2 inches thick of cement mortar to be absolutely sure that they are air-tight.

Large numbers of stoppings are built of concrete, either plain or reinforced to add to the strength. It should be noted here that it is very questionable if a stopping can be built strong enough to resist the force of the most severe explosion that might occur in the mine where it is used, and, as explained under the subject of overcasts, it is questionable if it would be well to so build them. Such being the case, and assuming that the only forces acting upon the stopping be those of the atmospheric agencies (neglecting the insignificant pressure due to the difference in water gauge in parallel entries and to having to support a few inches of draw slate), it is obvious that a much cheaper construction is permissible than is necessary in, say, bridge piers, foundations for high buildings, etc.

Concrete for stoppings is commonly made in the proportion of 1 :2 :4 to 1 :3 :6. This means that 1 volume of Portland cement is mixed with 2 volumes of sand and 4 volumes of broken stone, or that 1 volume of cement is mixed with 3 volumes of sand and 6 volumes of stone. In the first, which is the stronger, there is 1 volume of cement to 6 of sand and stone combined, and in the second, 1 volume of cement to 9 of sand and broken stone. It is to be noted that one bag of Portland cement weighs about 94 pounds and occupies (in the bag) from .9 to 1 cubic foot. The sand and stone are of course measured loose, or as they are hauled from the sand pit and stone crusher. The sand used should be sharp, that is, of clean, gritty grains, free from clay, loam, or vegetable matter; something often difficult to obtain about a mine, so that much inferior material is used. The stones should be freshly quarried or unweathered sandstone, granite, trap, or similar rock which does not contain lime. Lime is practically sure to be eaten up sooner or later by the sulphuric acid general in mine waters, even if enough is not present to be noticeable to the taste or to prevent its use in steam boilers. If crushed stone cannot be had, gravel answers every purpose and is usually cheaper. The size of the stone used depends upon the thickness of the wall; the thinner the wall, the smaller the stone. For a wall 9 inches thick, it would be well not to include any stone larger than a medium sized egg. Sand is sometimes unobtainable, and then coke yard ashes or very fine breeze are used in place of it and the stone. The ashes should be clean and free from pieces of firebrick and clay (used to daub doors). It is to be remembered that concrete made up of cinders has less than one-half the strength of that in which sand and stone are used.

For extremely strong stoppings a 1:1:2 concrete may be used, that is, one in which 1 part of Portland cement is mixed with 1 part of sand and 2 of broken stone. This may be reinforced with steel rods of about ¾ inch in diameter, or even with steel rails if an attempt is made to make the stoppings explosion-proof, as is sometimes done with those near the intake. These rods are set vertically from 3 inches to 9 inches apart, the closer the spacing the greater the strength. It is, of course, possible to make a latticework of steel by placing a second row of rods horizontally.

In building concrete brattices (stoppings), it is advisable to cut out a groove or "hitch" from 2 inches to 6 inches or more deep in the roof, floor, and ribs, to make a shoulder against which the finished stopping rests. If the stopping is to be reinforced, it is well to make this groove 12 inches or more in depth as the resistance of the roof, floor,

and ribs adds to the total strength of the brattice in event of an explosion. The width of the groove is, naturally, the width of the stopping, say, 9 inches in ordinary cases, and 18 inches to 24 inches for those which are extra strong and reinforced.

Planks from 8 inches to 12 inches wide are secured against each side of this groove to form a trough, in which the concrete is placed and tamped. As soon as this trough is filled to the height of the first set of planks another set is added, then filled, and so on until the roof is reached. The planks are allowed to remain in place until the wall has set, which may require from 2 to 4 days, when they are taken down and may be used again. After hardening, both sides of the brattice may be coated with cement mortar from ½ inch to 2 inches thick, particular attention being paid to making airtight any crevices at the roof, floor, and sides. It is apparent that all rods, etc., used for reinforcing must be placed before the concrete is placed in the trough. Concrete should be thoroughly mixed so that the ingredients are uniformly distributed throughout the mass. This may be accomplished by skill and attention on the part of the man doing the work, or by a machine known as a concrete mixer. Numerous concrete mixers mounted on trucks and designed for mine use are on the market, and catalogs and descriptions may be had from advertisers of such goods in the technical papers. In some of these the iron barrel in which the mixing is done is turned by an electric motor drawing current from the trolley wires, or compressed air or gasoline motors, or hand power may be used to turn them.

The use of these machines is to be recommended and particularly so if many brattices have to be built at one time, as when the wooden stoppings in a long entry are to be replaced by those made of concrete. When mixed by hand, it is customary to do this upon a sheet of steel such as that used for lining the chutes on a tipple and from 6 feet to 8 feet square. This commonly has one or two large holes near one edge in which hooks may be inserted to draw it by hand power or mule power from one brattice to another. In event of the work being done at night when the entries are not used for hauling, it is an excellent plan to have the mixing done upon the floor of a four-wheeled truck, which is left on the track and is pushed by the men or hauled by a mule or motor from place to place as the necessities may require.

Concrete should be mixed at the time it is needed and under no circumstances should that be used which is partly set. It should not be mixed or used too wet; that is, it should not run like mud. The right consistency can be determined only by experience, but roughly, may be likened to that of a sand or gravel pit after a heavy rain, and soon after the surplus water has run off.

The legislation concerning the construction of brattices is not at all uniform in the different states. In Illinois it is provided that "All cross-cuts connecting inlet and outlet air-courses, except the last one nearest the face, shall be closed with substantial stoppings to be made as nearly air-tight as possible. In making the air-tight partitions or stoppings, no loose material or refuse shall be used." The Pennsylvania anthracite laws provide that "All cross-cuts connecting the main inlet and outlet passages of any district, when it becomes necessary to close them permanently, shall be substantially closed with brick or other suitable building material, laid in mortar or cement whenever practicable, but in no case shall said stoppings be constructed of plank except for temporary purposes." The laws of Ohio state that "Brattices between permanent inlet and outlet airways shall be constructed in a substantial manner of brick, masonry, concrete, or non-perishable material." The Pennsylvania bituminous laws provide that "In all mines all new stoppings in cut-throughs between the main intake and return airways shall be substantially built of masonry, concrete, or other incombustible material, and shall be of ample strength; and in mines generating explosive gas all new stoppings and renewals of old stoppings in cross-entries shall be built of masonry, concrete, or other incombustible material. Stoppings in cross-entries in non-gaseous mines may be built of timber." In Indiana, "All break-throughs or airways, except those last made near the working faces of the mine, shall be closed up and made air-tight." In West Virginia, "All the break-throughs between the intake and return airways not required for the passage of air shall be closed with stoppings substantially built with suitable material, which shall be approved by the district mine inspector." In Alabama the law requires that "In all mines with 20 tons or over daily capacity, all stoppings between slopes and manway shall be made of fireproof material."

International Engineering Congress

An International Engineering Congress is being arranged in connection with the Panama-Pacific International Exposition, and will be held in San Francisco from September 20 to 25, 1915. The American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers, who are responsible for the organization of the Congress, extend to the Members of The North of England Institute of Mining and Mechanical Engineers a most cordial invitation to attend and participate in the proceedings. Various committees are now actively at work, and further and more definite announcements as to membership fees, schedules of papers, and other matters, will shortly be made.

NEW MINING MACHINERY

Portable Substation for a Coal Mine

The Berwind-White Coal Mining Co., Windber, Pa., has recently added a 400-kilowatt Westinghouse portable substation, shown in Fig. 1, to its equipment, and are making a very interesting use of it.

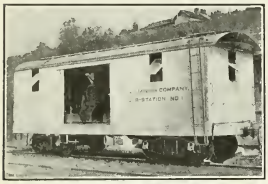


Fig. 1. Portable Substation

A substation consists of apparatus for changing alternating current into direct current, and is generally necessary in mining work, because direct current must be used for haulage in mines, but cannot be transmitted economically over long distances. Hence, when the mine is located some distance away from the power station that serves it, electric power can be transmitted more efficiently as alternating current at a high voltage and then transformed to direct current in the substation.

The Berwind-White company is developing its outlying properties very rapidly and needs direct current at points where permanent substations are not yet erected. In order to prevent delays in the development, the use of a portable substation was decided on.

This substation has the same equipment that a permanent installation has; namely, transformers to step down to a moderate value the high voltage of the current received from the transmission line, a switchboard, and a rotary converter, which receives alternating current and delivers direct current. This apparatus is mounted in a car resembling an ordinary freight car.

When the work at a new development reaches the point where direct current is necessary, the portable substation is hauled out to the workings, connected to the alternating current transmission system, and is started to work generating direct current. When the permanent substation is built the portable one becomes unnecessary, and is taken to the next development.

A further use of this substation is to provide insurance against shutdowns. If accidents occur at any of the permanent substations, the portable outfit is sent to carry the load until repairs are completed. One portable substation, therefore, is practically the equivalent of a duplicate set of apparatus at each permanent substation.

A New Room Hoist

The difficulty of securing and holding coal miners is said to have been lessened by the introduction into mines of a light hoisting apparatus, primarily designed to haul loaded cars from rooms having an up grade to the entry, or empty cars up the grade to the room face. It was afterwards found serviceable in replacing mules and horses in collecting and delivering cars in rooms, thereby eliminating the necessity for a rapidly depreciating and hazardous investment. Further, the hoist is claimed to be a substitute for gathering locomotives where they have been used for room work, and represents a smaller investment, as well as a very efficient means of performing work.

The hoists are made with either single or double drum, and are not miniatures of another electric hoist, but were designed after a study of prevailing conditions. The single-drum hoist can be furnished mounted on a truck, which has a track gauge of 30 inches and more. The truck carries a pair of spools between which the rope passes, making it possible to pull from either side of the truck at any angle. The machines are also furnished with bedplates, so that they can be used in many situations as stationary hoists; for instance, where the down grade is such that the cars will run by gravity to the room face; or, if they will not, use can be made of two drums and two ropes, one for pulling the cars in to the face, and the other for pulling the loaded cars out. In the case of an up grade, two ropes could be used.

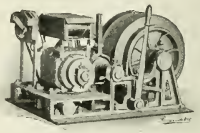


Fig. 2

The single-drum hoist shown in Fig. 2 mounted on a truck weighs 830 pounds without wire rope and has the following overall dimensions: length, 38 inches; width, 28 inches; height, 26 inches. Arrangements are provided so that the drum may be engaged with the motor-driven gears through a positive clutch, and by throwing out the clutch the drum can run on its shaft, under the control of its brake. The rope drum is cast iron with space for winding 700 feet of ⅜-inch or 400 feet of ½-inch-diameter wire rope.

The sketch, Fig. 3, shows the way in which the portable outfit can be used to serve any number of rooms or places. The truck is chained to

the track when pulling from rooms. The outfit is light and can be pushed from room to room, but should the grade be so heavy as to make this work difficult, the rope can be attached to the track some distance ahead and the hoist requisitioned to pull the truck into place.

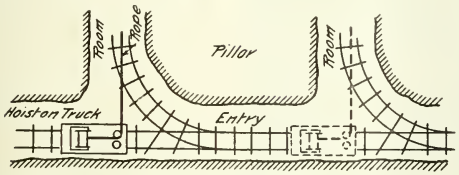


Fig. 3 Single-Drum Room Hoist

The double-drum hoist weighs 1,360 pounds complete and has the following overall dimensions: length, 38 inches; width, 44 inches; height, 26 inches. The performance of either the single- or double-drum hoist, is furnished in the following table prepared by the Pneumelectric Machine Co., of Syracuse, N. Y.:

Performance of Pneumelectric Room Hoist Double and Single Drum

Rope Pull in Pounds	220 Volts				500 Volts			
	Rope Speed Feet Per Minute	Amperes Input	Temperature Rise		Rope Speed Feet Per Minute	Amperes Input	Temperature Rise	
			Degrees C.	Minutes			Degrees C.	Minutes
100	460	6.0	45	85	475	2.8	45	80
300	289	11.0	45	40	316	5.7	45	27
500	233	15.0	45	22	277	8.3	45	11
700	208	19.0	45	12	233	10.6	45	5
900	185	23.2	45	7	200	13.2	45	3
1,100	160	27.6	45	4	179	15.8	60	3
1,300	144	31.7	45	3				

The Improved Hirsch Electric Mine Lamp

When the Hirsch electric mine cap lamp was given practical trials 2 or 3 years ago, it was evident that distinct progress has been made in the production of a convenient and practical electric mine lamp. That it was not perfect, and that there were some serious defects in its construction, was the opinion expressed by some of the leading coal mine managers. Naturally, the Hirsch company spent considerable time and money in efforts to correct the actual defects, and as a result, the Hirsch lamp, as at present constructed, is a remarkably safe, convenient, and efficient mine lamp, and it has been approved by the United States Bureau of Mines as permissible for use in gaseous mines. Briefly stated, the improvements are as follows:

The battery has been improved by supplanting the liquid formerly used by a solid or jellied substance which effectually prevents leakage, and the sulphating of the plates.

The old connections of the wires from the battery to the cap lamp have been replaced by more convenient and more substantial socket connections, which make impossible external sparking.

The wires leading from the battery to the lamp which were formerly heavily insulated conductors are now encased in flexible light brass armor, so that they are perfectly protected from injury and short-circuiting.

A marked improvement in the lamp itself is the arrangement whereby, if accident should occur through which the bulb enclosing the incandesced filament is likely to be broken, the current is cut off and the incandescence ended before the bulb can possibly be injured.

In the construction of the battery, improvements have been made so that the present form will last 12 hours without recharging, when it can easily be recharged with direct current.

Safety Powder Cans

A safety can for the use of miners when filling cartridges, has been devised by D. W. Marsh, with the object of preventing the spilling of powder and exposing powder to fire from lamps. A further object is to provide means for filling the can from a keg of powder without the danger from spilling or exposure to fire. To the right in Fig. 4 is shown the can in position to load a cartridge. The nozzle of the can having been inserted in the cartridge, and the two held in the position by one hand, as shown, the slide in the neck of the can is pulled open by the other hand and the powder runs into the cartridge. When the latter is filled, the hand is removed from the slide which is pushed back by a spring, and this stops the flow of powder from the can.

The method of filling the can from the powder keg is shown to the left in Fig. 4. In this manipulation there is a nozzle attachment for the keg, which fits the neck of the can. Here again the spring and slide come into play, and as the nozzle on the can and the nozzle on the keg are tightly connected, there is no possibility of the powder spilling while loading the can.

When the can is filled, the slide

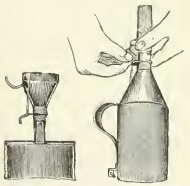


Fig. 4. Safety Powder Can

cutting off supply of powder from the keg is pushed back into place by the release of the spring, the keg and can are then inverted, when any powder in the nozzles connecting the two runs back into the keg. The de-

vice is similar to the powder measuring attachments once so generally used by hunters for loading shells, with, of course, the necessary changes to make it apply to the case of mine cartridges.

Belgian Tests of Hailwood Lamps

The Belgian Government has approved the Hailwood naphtha lamp, and the Hailwood oil lamp, manufactured by Ackroyd & Best, Ltd., Pittsburg, Pa. The Belgian Government lamp tests are said to be far more severe than those of other governments; mine gas from the Grand Trait mines being employed in the tests. The lamp is subjected to the most explosive mixtures of air and gas at velocities of 5, 7, 9, 11, and 15 meters per second or velocities of from 984 to 2,950 feet per minute. The series of tests are:

Downwardly descending currents at 45°.

Upwardly ascending currents at at 45°.

Vertical descending currents.

Vertical ascending currents.

The whole series of tests were repeated in currents of air and gas traveling horizontally.

A Kerosene Blow-Pipe

For the purpose of making repairs to steel mine cars, bending rails and pipes, and assisting in other matters about mine shops, the Hauck Manufacturing Co., of Brooklyn, N. Y., are putting on the market kerosene blow-pipes. One of these is shown in Fig. 5, heating a rail previous to bending. The tank contains compressed air and kerosene; the oil is driven through one pipe by the air to the burner nozzle, while the air passes through another pipe and converts the oil into a fine spray, which leaves the nozzle in a flame, causing intense heat. In situations where machine compressed air is not available, hand compressed air pumps are connected to or form a part of the tank. It is claimed by the manufacturers that the blowpipe may be utilized in straightening shafts and girders, expanding locomotive driving wheel tires, melting

Fig. 5. Oil Fuel Burner

out bearings, and preheating preparatory to welding, etc.

Welch Hoisting Engine Controller

Mr. C. R. Welch gave a practical demonstration of his hoisting engine controller in Butte, Mont., at the Mountain View mine, before C. F. Kelley, vice-president of the Anaconda Copper Mining Co., John Gillie, superintendent of the same company, Thomas Mitchell, of the Leonard mines, State Mine Inspector Orem, Master Mechanic Lily, and others.

The Mountain View hoister weighs more than 300 tons and runs very fast. The engineer at the demonstration tried to make the engine run away descending and ascending, but the device foiled his endeavors each time. He would leave the throttle open, giving the engine full steam, and, as the engine gained excessive speed, the safety applied the brakes and stopped the engine automatically. He also put the throttle wide open with the cage approaching the surface, and the safety applied the brakes, stopping before reaching the danger zone. The demonstration showed that a runaway at either end of the shaft will be impossible with the safety controller attached.

Mr. Welch, who is an old mining man and engineer, equipped several plants in Butte with his device 5 years ago. The device was crude then, but the Anaconda company officials say it has prevented overwinding accidents with the engines to which the safeties are attached. With the improvement added, the device becomes a perfect working apparatus, and it is said practically all the engines of the Butte camp will adopt it.

Mr. Welch has placed 400 safety controllers in the different mining states. He has eight trained mechanics, whom he keeps busy near his Pittsburg home, equipping plants in different mining countries. Three states have passed laws requiring safeties on hoisting plants, Colorado, Alabama, and Pennsylvania. It is estimated by conservative mining men that this safety controller is saving the lives of 20 men annually and the destruction of probably $500,000 worth of property. Superintendent John Gillie and State Mine Inspector Orem, indorse this device, and it responded so quickly to trials made in the anthracite fields that were viewed by the Editor an article regarding it was written for The Colliery Engineer, and the Lake Superior Mining Institute.

Large Electric Hoist

The directors of the North Butte Mining Co., awarded the Westinghouse Electric and Manufacturing Co., the contract for what will be one of the largest electric hoists of its kind in the world.

The hoisting drums, 12 feet in diameter, will be driven by a direct-connected electric motor making about 71 revolutions per minute. Hoisting will be done in balance, but the equipment is large enough to take care of the load with unbalanced hoisting.

Two 7-ton skips will be used for handling the ore, and 1⅝-inch diameter round rope which will have a normal speed of 2,700 feet per minute, with a maximum of 3,000 feet per minute, will be used.

This hoist is for the new Grant Mountain shaft, which at present is about 2,900 feet deep.

The capacity of the hoist will be 300 tons of ore per hour from the 4,000-foot level.

stant throughout any cycle of hoisting.

Some high economies have been guaranteed by the manufacturers, and this installation will be watched with interest, particularly with a view of comparing its economy with that of the pneumoelectric hoisting system, designed by Mr. Bruno Nordberg, being used at 10 of the Anaconda mines.

There are larger electric hoists in

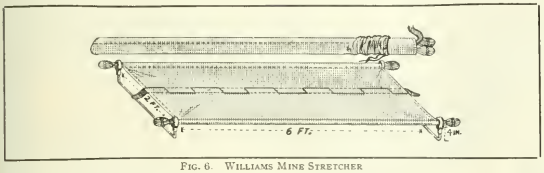


Fig. 6. Williams Mine Stretcher

The Ilgner system of control and power equalization, will be used, in which a 50-ton flywheel driven by the motor generator set is permitted to give up some of its stored energy to supply the peak load drawn by the hoisting motor from the power line during the period of starting and acceleration.

The hoisting motor will be of the kind used in steel mills and will be of a heavy construction; in fact, the electrical equipment will weigh in excess of 250 tons.

A number of special safety devices are included in the equipment, including electrically released brakes; automatic slow-down devices to prevent skip or cage ever going through the head-sheaves, and a special controller to limit the speed when hoisting men.

The hoist motor will have a maximum intermittent rating of 4,500 horsepower, and the motor-generator set will be driven by an induction motor having a continuous normal rating of 1,400 horsepower.

The difference between these ratings represents approximately the amount of energy that will be supplied by the flywheel momentarily during starting.

The installation is so designed that the draft of power from the power line will be practically constant throughout any cycle of hoisting.

South Africa, a few of which use the Ilgner system of power equalization, but most of these South African hoists do not attempt to obtain power equalization.

Williams Mine Stretcher

The Williams mine stretcher, made by the Wheeling, W. Va., Tent and Awning Co., can be rolled up and carried or stored in a canvas bag which keeps it free from dirt. The stretcher was devised originally for use in ambulances and hospitals to convey sick and injured with as little discomfort as possible, but by improvements it now is said to be the only stretcher the patient does not need to be lifted from. This will appeal to the managers and surgeons of coal companies having first-aid corps.

When folded, the stretcher occupies a bag 7 feet long and 5 inches in diameter. When in use it does not sag and cause additional pain to the injured. The stretcher, as shown in Fig. 1, is fastened in the center by a canvas strip which, when pulled out, permits the bed of the stretcher to part as shown by the lines. The bed is kept taut by two spreaders, one at each end, which are held in place by the side bars and handles.

TRADE NOTICES

Mine Doors.—Among the requirements of the British Mine Law is one that states in substance that mine doors are to be constructed so that they will not blow open when the air is reversed. As the mine door manufactured by the American Mine Door Co., in Canton, Ohio, meets this requirement, W. K. Bowman, general manager of the company, is much pleased with his trip abroad.

The Nelson Valve Co., of Chestnut Hill, Philadelphia, Pa., announce that they have recently taken over the manufacture and sale of the Erwood swing gate valve, formerly made by Messrs. Walch & Weyth, of Chicago. This valve is recommended for the following purposes: Back pressure to the atmosphere; atmospheric relief on turbines and condensing engines; safety gate on exhaust lines of pumps, hammers, elevators, etc.; non-return between cylinders and condensers; non-return between open heaters and engines; safety gate on air lines of air compressors; self-cleaning foot-valve on suction pump; combined check and gate on discharge of pump. A large number of these valves have been installed by the leading power houses throughout the United States, and they are looked upon with favor among engineers. In the future the valve will be known as the Nelson-Erwood swing gate valve.

The Issaquah and Superior Coal Mining Co., of Washington, recently completed a screening and washing plant at their Issaquah mine. The Link-Belt Co. had charge of the work, and have built a very modern cleaning plant. The Pacific Coast Coal Co. is also remodeling its Coal Creek plant with a modern plant, similar to the one at Issaquah, and made by the same firm.

Nonpareil Insulating Brick is a new product designed for the insulation of boiler settings, furnaces, breechings, stacks, kilns, etc. This material has mechanical strength sufficient to enable it to be used structurally and also resists relatively

high temperatures. It is made by the Armstrong Cork Co., of Pittsburg, Pa.

Improved Automatic Injector.—The Lunkenheimer Company, of Cincinnati, Ohio, manufacture an automatic injector which they claim is exceptionally durable, and economical.

The tubes, which are the parts subjected to the greatest wear, are made of a special bronze of extreme hardness, and the injector can be subjected to long and severe usage before any sign of wear on the tubes appears. The design of the tubes aids in prolonging their efficiency, even after considerable wear takes place within them, and new tubes can be inserted at a small cost. The amount of water delivered can be graded over 50 per cent. under all ordinary conditions, and a saving in fuel is accomplished because of the large amount of water delivered per pound of steam and the capacity of the injector is but slightly diminished by long lifts and hot feed-water. The injector is absolutely automatic and can be relied upon to restart instantly after a temporary interruption of either the steam or water supply.

The Lunkenheimer Company have issued an attractive catalog describing their injector, and other specialties. This will be sent free to any one asking.

Removal.—The Williams Patent Crusher and Pulverizer Co. announce the removal of their General Sales Department to more commodious quarters, suite 1585-1588, Old Colony Building, Chicago, Ill., and extend a cordial invitation to all friends and customers to call upon them at any time.

ANNOUNCEMENTS

The Northern Conveying Machinery Co., announce the change of name to Manierre Engineering and Machinery Co., successors to the Ticknor-Manierre Co. The loader formerly known as the "Milwaukee" loader will in the future be known as the "Manierre" loader, and their offices have been removed to 709-10 Manhattan Bldg., Milwaukee, Wis.

Safety Calendars

The National Tube Co., of Pittsburg, Pa., is giving each one of its employes, approximately 30,000 in number, a safety calendar, which is to be hung in the house as a daily reminder of the "Safety First" idea.

Each sheet of the calendar shows a picture where a man is thoughtful enough to see that there is no danger before he undertakes to do a thing which might, without carefulness, lead to an accident. Each monthly sheet is illustrated and bears an appropriate motto bearing on carefulness.

Catalogs Received

Nelson Valve Co., Chestnut Hill, Philadelphia, Pa. Triple Tested. Circular.

Koehler Mfg. Co., Marlboro, Mass. Circular, Miners' Safety Lamp, System Koehler.

Wm. Powell Co., Cincinnati, Ohio. "Powell" Grease Cups, 14 pages.

Gardner Governor Co., Quincy, Ill. The Gardner Horizontal Duplex Air Compressors, 7 pages.

Pneumelectric Machine Co., Syracuse, N. Y. Hard Facts About the Pneumelectric Rock Drills As Applied to Coal Mines, 8 pages; Room Hoists, 15 pages.

Jos. Dixon Crucible Co., Jersey City, N. J. Valuable Graphite Products, 22 pages; Wire Rope Lubrication, 14 pages.

Goldschmidt Thermit Co., 90 West St., New York, N. Y. Thermit Welded Pipe Joints—Permanent and Non-leakable. Cost Less Than Fittings, 12 pages; The Thermit Welding System, 9 pages.

H. W. Johns-Manville Co., 41st St. and Madison Ave., New York, N. Y. J-M Fiber Conduit, 13 pages.

Armstrong Cork Co., Pittsburg, Pa. Nonpareil Insulating Brick, 31 pages.

The Fiber Conduit Co., Orangeburg, N. Y. Orangeburg Conduit, third edition, 84 pages.

Cleveland Rock Drill Co., Cleveland, Ohio. Cleveland Hammer Drills, 23 pages.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Chicago Portable Mine Hoist, 7 pages.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Story of the "Imperial," 21 pages.

Calendars Received

Revere Rubber Co., Chelsea, Mass.; Hazard Mfg. Co., Wilkes-Barre, Pa.; National Tube Co., Pittsburg, Pa.; The Ironsides Co., Columbus, Ohio.; The Bittenbender Mfg. Co., Scranton, Pa.; Baldwin Locomotive Works, Philadelphia, Pa.; John A. Roebling's Sons Co., Trenton, N. J.

What Next?

Steam shovels are employed in the Brazil Block, coal field, of Indiana, as in other coal fields, for stripping coal seams, or parts of seams, near the surface.

The *Daily Times*, of Brazil, Ind., on January 8, published the following:

The following resolutions have been received by the officials of the U. M. W. of A., District 8:

Boonville, Ind., Dec. 17, 1913

To the 24th Biennial Convention at Indianapolis of the U. M. W. of A., assembled January 20, 1914:

Whereas the steam shovels have made their appearance in Warrick County, to the detriment of the miners and citizens of the southern part of the state of Indiana. And,

Whereas the land occupied by these steam shovels will be made a desolate waste and irrevocably destroyed for the next generation to come. And,

Whereas the miners of this part of the state will be deprived of their occupation and their means of livelihood. And,

Whereas the citizens of Boonville and community are desirous of making some effort to checkmate this menace before it becomes disastrous. Therefore be it

Resolved—That our convention now assembled heartily condemn the practice of stripping coal by these steam shovels. And be it further

Resolved—That our international executive board and officers be instructed to cooperate and assist any movement which may be made by the people of this community.

Signed:

Ed. Thurber, President,
Fred Helms,
Gus Balm,
Jos. O'Loughlin,
Committee.

Jack Bufkin, Sec. Com.; J. M. Nicholoson, President; Andrew Helmbock, Rec. Sec., C. L. U. Boonville, Ind.

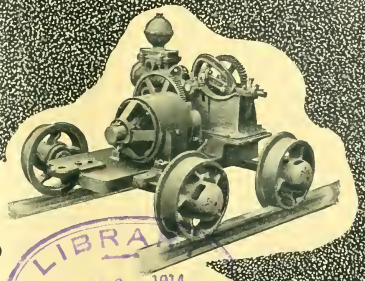
Such action on the part of any class of men in this generation seems incredible. Further comment is unnecessary.

The Colliery Engineer

ol. XXXIV—No. 8 MARCH, 1914 Scranton, Pa.

habetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68



Goes
Where
An Ordinary
Pump Won't Go

Compact and Durable.

Two horse power Motor designed especially for mine pump work. You can't beat the

FAIRMONT PORTABLE Electric Mine Pump

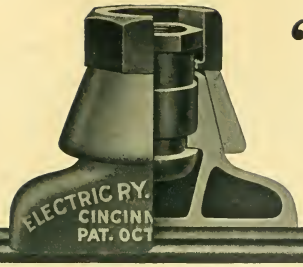
unless you cheat.

Absolutely the Best Gathering Pump Made.

You say we can't prove it?
Well, let us show you.

Wire us today to send you one on **thirty days free trial;** or send for Bulletin No. 13. It tells why.

FAIRMONT
MINING MACHINERY CO.,
Fairmont, West Virginia.



"SURE GRIP" Trolley Clamp

Positive insurance against dangling wires and mine runaways

A TROLLEY clamp with a vise-like grip of the wedge principle—easily applied to figure 8 or grooved wire, even when wire is bent or kinked. And as easily removed for use in other parts of mine. "Sure Grip" has wide opening jaws—but short, so that they do not interfere with trolley wheel on curves. No exposed threads to be corroded by mine water.

Ask for Catalog 14

Electric Railway Equipment Co.

Main Office and Works - - - - - - - - - Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.
H. G. Behneman
316 James St., Seattle, Wash.
Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.
Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio
Cooke & Wilson Co.
Charleston, W. Va.
Mine & Smelter Supply Co.
Denver, Colo.
Mine & Smelter Supply Co.
El Paso, Texas
Mine & Smelter Supply Co.
Salt Lake City, Utah
C. M. McClung & Co.
Knoxville, Tenn.
McClary-Jemison Machinery Co.
Birmingham, Ala.
J. G. Kipp, 30 Church St.
New York City, N. Y.
Grayson Railway Supply Co.
408 La Salle Bldg., St. Louis, Mo.
Arthur L. Ware
Jellico, Tenn.
Superior Supply Co.
Bluefield, W. Va.

INSULATED WIRES AND CABLES

FOR

Light, Power, Telephone, Telegraph
Mining Machines and Locomotives

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah Cleveland
(Office Atlanta)
San Francisco Los Angeles
Seattle Portland, Ore.

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXIV—No. 8 MARCH, 1914 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1891

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions; and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE, 14,700

TABLE OF CONTENTS

Editorial—

A Quake—No Explosion—Common Sense Regarding Surface Settlements—Earthquakes and Mine Explosions 459

Mining Exhibit at the Panama-Pacific Exposition 462

Income Tax and Forestry 462

Steel Corporation Mines at Gary, by W. Z. Price 463

British Coal Dust Precautions, by C. F. J. Galloway 472

Automatic Chute Stop 474

Black Diamond Concrete Tipple, by Wilbur Greeley Burroughs 475

Canadian Mining Institute 478

Economical Lubrication, by W. W. Davis 478

Depth and Thickness of Anthracite Seams 481

Conditions Affecting Mining in the Bering River and Matanuska Coal Fields, by W. R. Crane 481

Uplift in West Virginia 486

The Longwall Method of Mining, by Alexander Sharp 486

Nature of Permissible Explosives, by Clarence Hall 491

Fire at Consolidation's No. 21 Tipple 494

Moving Pictures for Accident Prevention 495

Welfare Work of the Kingston Coal Co. 497

Gas in Coal 499

Capacity of Pipes and Cylinders 501

Kingston Coal Co.'s Hospital 501

Cooperative Central Station Possibilities, by David R. Shearer 502

Large Armored Cable, by F. J. Deemer, Jr. 504

International Congress of Social Insurance 505

Recovering Oil and Waste 505

Personals 506

Pyrene as a Fire Extinguisher, by Frank C. Perkins 507

Book Review 508

The Interferometer 609

Prize Contest 511

The Letter Box—

Pumping—Influence of Earthquakes—Capacity of Car—Haulage Problem 513

Examination Questions—

Examination for Mine Manager, Mine Examiner, and Hoisting Engineer, Springfield, Ill., September 8 and December 15, 1913 515

Steel Slack Bin 518

New Mining Machinery—

Rock Drill Operated by Gasoline Engine, 519—Sells Roller Bearings for Mine Cars, 520—Electric Safety Lamps for the Powder Men, 520—Locomotive Record at Scalp Level, 521—Improved Measuring Tapes 521

Trade Notices 521

Catalogs Received 522

Squibs—

Coalinga Oil Field, 482—Conservation Begins at Home, 495—Useful Information 510

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

A Quake—No Explosion

ON FEBRUARY 10, a seismic disturbance of considerable magnitude was plainly noticed in several parts of the anthracite region of Pennsylvania, by the shaking of buildings, rattling of china, etc. Seismographs at Washington, D. C., at Cornell University, Ithaca, N. Y., in New York City, and other points in the northeastern section of the United States and in eastern Canada recorded the earthquake movement. Telegraphic news items have not recorded any great outflows of gas or disastrous explosions in coal mines in Europe or Asia, and mine officials in the anthracite fields in the zone of the movement, report no change from normal conditions, as to gas. No troubles due to the quake have been reported in any of the coal fields of the United States or Canada.

Common Sense Regarding Surface Settlements

THE towns and cities of the Anthracite Fields of Pennsylvania, like Topsy, "just grew." They were born and nurtured through the development and mining of the coal, and their prosperity was, and is, primarily dependent on the mining industry.

If the present owners of the coal were to lay out towns now, every possible municipality would be located close to, but outside, the coal measures.

There is, owing to present locations, a serious consideration confronting all towns in the anthracite fields, and this condition is made worse by exaggerated sensational matter published in newspapers of general circulation. It is with regret that we notice other periodicals, not of general circulation, publishing articles on the subject that are misleading and mischievous.

The newswriters employed on daily papers and by news-gathering agencies are not mining engineers and do not claim to be. They are trained to make the most possible out of a news item, because a large part of the American public demand news dished up in a sensational manner. Therefore, items that ordinarily occur in all parts of the country, such as minor fires, etc., are given but little prominence, while "mine caves," as they incorrectly call surface settlements over mine workings, which have in many instances caused less damage than thou-

sands of other occurrences, are published with "scare heads" and lurid vocabulary.

While in certain sections of some towns and cities in the region there have been, and will be, surface disturbances, the damage done has been, as compared to fires, etc., but little. Naturally when the damage, as has in most instances been the case, occurs to the small home of a citizen whose life's savings, in whole or greater part, are invested in that home, the damage is far greater individually, than if it had occurred to the more expensive home of the wealthier man whose capital is not all locked up in his residence. Therefore, every man with a spark of feeling, and this even includes the mine managers, sympathizes with those whose homes have been damaged. Owing to Scranton being the largest town in the region, and the fact that mining under certain sections of the city has, and eventually will, cause settlements in those sections, the sensational and exaggerated reports of actual occurrences have done a certain amount of damage to the city as a whole. That the city is not a "doomed" city is evidenced by the fact that the D., L. & W. R. R. Co., the officials of which are fully posted as to actual conditions, has within the past 5 years built extensive car shops in the extreme western section of the city, and particularly fine and well equipped locomotive and machine shops in the southern section, at an approximate expense of $5,000,000. Both of these plants could have been located at points outside the coal measures, and would have been, if the D., L. & W. officials believed the city was not a permanent one. Besides these shops, the same railroad company also erected a station and office building, which with track arrangements and approaches represents an outlay of over $1,000,000. This station is regarded as the handsomest railway station of its size in America. Other large office and business buildings erected in the city were built by men who, being perfectly familiar with mining conditions, did not hesitate to invest their money in such structures. There is no stronger evidence of the falsity of the exaggerated notions of the general public regarding Scranton's security as a city, than these buildings.

Realizing that the sensational reports of surface settlements was injuring the city, at a recent meeting of the Board of Trade, one of the members offered a resolution that the editors of the local papers and local representatives of news agencies be requested by the secretary to treat damage to real estate by surface settlements in the city, in the same conservative way in which they would note a fire or other accident entailing the same monetary loss. In his remarks prefacing the resolution, the proposer called attention to several absolutely false statements in metropolitan journals and to the fact that local journals, that would dismiss a fire that caused several hundred dollars' loss, with a few lines, used black-faced large type for headlines and gave many times as much space for recording surface disturbances that in many instances caused much less loss. The motion was vigorously applauded and immediately seconded. One member, who did not seem to catch the intent of the motion, and who inferred it was on another subject, opposed it in a vigorous manner, and when the question was called, voted no. Inside of half an hour later, when he understood the motive of the motion, he sought the proposer, and expressed at least qualified satisfaction with it, so that to all intents and purposes the motion was unanimously passed by the largest assemblage of Scranton business and professional men of the year.

Scranton, as other towns in the region, has a problem to solve in the matter of adequate support to the surface. As some questions are now before the courts, they will be legally and fairly settled. When this has been accomplished, the coal owners, mine managers, and surface owners will unquestionably settle the matter in a way which will be satisfactory to those most directly concerned.

Earthquakes and Mine Explosions

In June, 1909, H. H. Stock, Professor of Mining, University of Illinois, then editor of this journal, published an editorial showing that the idea that earthquakes in one part of the world caused excessive outflows of gas in coal mines in other far-distant parts, as expressed by W. A. Spalding, of Los Angeles, Cal., was not worthy of consideration. Mr. Spalding's paper, which appeared in a mining contemporary, contained a table showing what the author thought to be explosions due to outbursts of gas caused by earthquakes in some far-distant part of the world.

Professor Stock, by careful research, found that in many instances Mr. Spalding's dates were wrong; and in all instances of examples of explosions cited, that could be conveniently investigated, the official investigations showed the accidents to be due to ignitions of gas, naturally given off in what might be expressed as normal quantities, and in most instances ignited by men who either violated colliery rules, or who, through ignorance or carelessness, did not observe natural precautions. In some instances the explosions were dust explosions initiated by the ignition of small bodies of gas or by blown-out shots.

At the meeting of the New York Section of the American Institute of Mining Engineers, held in New York City on January 16, N. H. Darton, Geologist of the United States Geological Survey, read an interesting and valuable paper on "The Occurrence of Gas in Coal." In this paper, Mr. Darton did not mention any supposed relation between earthquakes and increased outflows of gas; but, in the discussion that followed, one of the members present injected the subject, and presented views which did not meet with much favor from the members present.

In the issue of a mining contemporary for January

24, with which the member referred to is connected, appears an editorial entitled "Seismic Disturbances in Its Relation to the Flow of Gas in Mines."

This editorial states that "Numerous notable examples of *danger periods in coal mines* occurring simultaneously with *periods of seismic unrest,* it was generally agreed make it a reasonable matter for careful study and investigation." The "general opinion" as shown by the stenographic reports of the discussion was exactly opposite to the above quoted statement, and it is doubtful if any of the able men who took part in the discussion, except the originator, care to be classed as thinking the matter worthy any more serious thought.

One phrase in the quoted sentence: "*danger periods in coal mines*" will strike practical mining men as a peculiar one. Of course the writer referred to mines generating explosive gas, and if there is any one type of mine in which the *danger period* is *all* the time, it is such mines as these.

In the editorial referred to the writer infers that the Mount Pelee earthquake on May 6, 1902, was the probable cause of four mine explosions resulting in the loss of 550 lives. He does not mention the localities of the mine explosions. The three large mine disasters in the United States occurring in 1902, were the explosion in the State mine at Nelson, Tenn., which occurred on March 31, thirty-six days previous to the Mount Pelee quake; the explosion at Fraterville, Tenn., on May 19, two weeks after the quake; the explosion at Johnstown, Pa., on July 10, two months after the quake.

The cause of the disaster at the Nelson mine, in which convicts were worked, was an absolute disregard of natural precautions necessary in a gaseous and dusty mine. Conditions in the mine were ripe for such a disaster at any time, and the one referred to was the third explosion in the same mine.

The Fraterville disaster was a dust explosion initiated by the ignition of a comparatively small body of gas, such as was frequently encountered in that mine.

The Johnstown, Pa., disaster occurred in a part of the mine where pillars were being robbed and where gas was normally so prevalent that open lights were prohibited. Investigation proved that the gas was fired by one of the workmen using a naked light. There was no evidence of the explosion having been a particularly violent one, and most of the victims were killed by the afterdamp.

In the same editorial the writer infers that the earthquake in Formosa, Japan, on March 17, 1906, was the cause of the Courrieres disaster in France that occurred on March 10, one week previous to the quake. The exhaustive investigation into this disaster by the French government officials fixed definitely the fact that the explosion was due to coal dust fired either by a slight explosion of gas, to the explosion of a shot, or a parcel of explosives. The two former suppositions are supported by the fact that naked lights were used in the heading in which the explosion started, in violation of the law, and that No. 1 Favier powder was used instead of safety explosives. That an earthquake in Japan did not cause an unusual outflow of gas at the Courrieres mine is proved by the fact that no unusual outflow of gas was recorded at any of the more gaseous mines in the same district of France, and that mines in Austria, Germany, Belgium, and in the western part of America, all nearer Japan than France, reported no unusual outflow of gas.

As regards the Takashima explosion, mentioned in connection with the Formosa quake, we have no convenient record of the date on which it occurred. If it occurred during the time of the seismic disturbance which exerted its greatest force in Formosa, it is possible that falls of top, upheavals of bottom, or a squeeze caused by a quake in the same general locality, may have caused an increased outflow of gas. This would possibly be the case in any coal field inside the established zone of disturbance.

In the article discussed the writer says the Formosa quake was almost immediately followed by the San Francisco earthquake. The facts are that the San Francisco quake occurred on April 18, or 31 days after that of Formosa. No extensive mine explosion is recorded in American coal mines in the entire balance of the year 1906, after the time of the latter quake. He instances the Valparaiso earthquake of August 16, 1906, as being "followed by a remarkable series of mine explosions at Bluefield, W. Va., 30 lives; Raton, N. Mex., 15 lives; Wingate, Eng., 25 lives; Johnstown, Pa., 7 lives; Pocahontas, Va., 35 lives, etc." The Report of the Department of Mines of West Virginia for the year ending June 30, 1907, fails to disclose explosions as noted above. Official investigations into such explosions as did occur definitely fixed the causes, and in no case was there an abnormal condition at the mine. The Wingate, Eng., explosion occurred October 12, 1906, nearly 2 months after the Valparaiso quake. If that quake caused an increased evolution of gas at Wingate, why did it not do the same at the scores of other gaseous British mines? The Johnstown disaster occurred October 24, 1906, over 2 months after the Valparaiso quake. The official investigation showed a feeder of gas had been opened in a "doghole" by the firing of a shot (a not unusual occurrence at the mine), and that two loaded mine cars standing in front of the "doghole" prevented the air-current from diluting the gas. After an absence of some 2 hours two miners entered the hole and ignited the gas. In extending its devilish power northward, the Valparaiso quake, in this instance overlooked the mines of Alabama, Tennessee, Kentucky, and West Virginia.

The Kingston, Jamaica, earthquake of January 14, 1907, according to this writer, was the probable cause of the explosion on January 23, at Primero, Colo.; of the explosion at Essen, Germany; of that at Stuart, W. Va.,

on January 29; that at Thomas, W. Va., on February 4, etc. In each of these cases the explosion was initiated by gas, but in no instance was the quantity evolved more than usual. In almost every case where the explosion was extensive, coal dust was known to be the most potent agent.

A further evidence that an earthquake in one part of the world does not affect the flow of gas in coal mines in another distant part, is that Mount Pelee and Kingston quakes, which occurred off the eastern coast of America, and the San Francisco quake on the western coast, did not in any case, cause an abnormal increase in pressure in American natural gas wells.

For 30 years, from 1869 to 1898, the Department of Mines of Belgium, under the personal observation of Mr. E. Harze, Director-General, made a most careful investigation into the influence of seismic disturbances on outflows of gas in coal mines. The results of these investigations showed that out of a total of 237 evolutions of gas noted, there were only three where there was a coincidence of time with disturbances of the seismograph, and one of these was doubtful.

In commenting on this, Mr. Harze said: "On the 19th of July, an earthquake was reported as occurring at Rome, Italy, at 20 minutes after 2. The phenomenon was also observed in Belgium, at the Military School. I wrote to the directors of nine collieries, located at different points throughout the coal regions from east to the west, inquiring if they knew of any unusual evolution of firedamp at the time of the quake. These nine collieries included no less than 43 different mines. All replied that there had been nothing unusual noted, though at some of the mines minute observations had been made to test the matter."

M. Victor Watteyne, Inspector General of Mines, of Belgium, in a letter to the former editor, expressed his opinion on the subject as follows: "There has never been established a distinct relation between earth movements and the evolution of firedamp. * * Concerning America, use good safety lamps where firedamp exists and especially avoid dangerous explosives, and you will have done more toward security than in establishing Meteorological Stations, which will give you information on all the earthquakes in the world."

Mining Exhibit at the Panama-Pacific Exposition

Charles E. Van Barneveld, Chief of the Department of Mines and Metallurgy of the Panama-Pacific International Exposition says:

"Let us display to the world the truth of the rest of the announcement in the Official Call of the Mining Congress: 'It (mining) is the one indispensable industry; through cooperation only can its importance command recognition and the best results be accomplished.'

"Completing the incentive that is urging mining men to exhibit fully at the Exposition, is the fact that there are many important questions, in which they are vitally interested, now pressing for settlement. The public is taking an increasingly active interest in forcing these questions to an issue, and if not blinded by prejudice nor deaf through ignorance, is essentially fair minded; it needs only education. With light on the subject, the miner may confidently expect fair play, but the illumination must be set, to the end that the public be given an insight into the importance of the mining industry, its need of wise legislation to insure equitable rights, and its need of public cooperation and support.

"Mining men generally see in the Exposition an opportunity for broadcast sowing of the seed of knowledge, and the more important the enterprises with which they are related, the more emphatic is their indorsement of the Exposition as a means of placing their industry properly before the public. The result is an assurance of a splendid mining and metallurgical exhibit worthy of the subject.

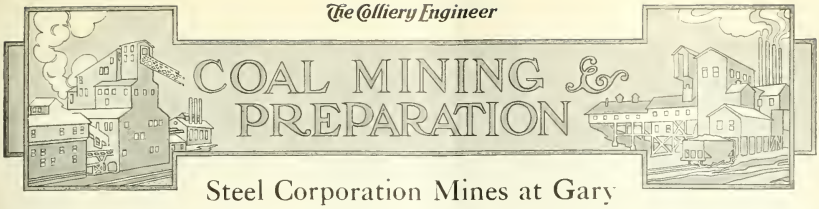
"In view of the almost inconceivable fact that during the last 25 years the mining industry of the country has contributed more than forty billions of dollars to the wealth of the nation, it is proper that the event celebrating the greatest achievement in engineering yet performed by man, should be the occasion of a display of the country's most direct agency of wealth—its mines—which helped to make the achievement possible."

One of the problems to be solved in the Coalinga oil field, of California, is, the exact location of the beds and the composition of their contained water which destroys both steel and iron casing in from 2 to 5 years; it is considered to be the so-called "black-sulphur" water.

Income Tax and Forestry

A decision of the Treasury Department in regard to the administration of the income tax is a strong argument for forestry. As the opinion of the Treasury officials is interpreted, no timberlands are subject to the tax until the timber is cut and marketed and then the profit only will be subject to an income-tax assessment. In other words, all costs will be deducted before the tax is levied, and these will cover the cost of growing the timber, including the cost of planting where necessary, and of protecting the growing crop.

This decision was based upon a request for information made by P. S. Ridsdale, secretary of the American Forestry Association. He asked if there would be a tax on the value of the yearly growth of timber whether it was cut or not, and also whether an income tax would be assessed on the value of the timberland. In reply, the Treasury Department said that "the gain from the cutting and disposal of stumpage is realized in the year during which the timber is cut and disposed of, and that the amount received in excess of the cost of such timber is profit, and should be so accounted for as income for that year."



Steel Corporation Mines at Gary

A Description of the Plant—The Numerous Wrinkles Employed—The Premium System—The Sociological Conditions

By William Z. Price

THE United States Coal and Coke Co., a subsidiary of the United States Steel Corporation, has made gigantic strides in West Virginia coal mining. The central offices of the company are at Gary, on the Tug Fork branch of the Norfolk & Western Railroad. The area under lease from the Pocahontas Coal and Coke Co. consists of 77,700 acres of surface, containing 50,700 acres of the Nos. 3, 4, and 5 seams, averaging over 4 feet in thickness. Of this area, 17,706 acres of coal are situated on the waters of Pinnacle Creek, in Wyoming and McDowell counties; the remaining 33,000 acres are along the waters of the Tug and Dry Forks of the Tug River, in McDowell County, W. Va., and in Tazewell County, Va. About 23,000 acres along the Tug River have been apportioned to the 12 plants now in operation, all of which are close to Gary. These plants are now developed and equipped to produce 6,000,000 tons annually. Practically all the coal is shipped to Joliet, Ill., and Gary, Ind., to be converted into coke in the by-product ovens.

Fig. 1. View of Gary, W. Va., Looking East

THE INDIVIDUAL OPERATIONS

No. 1 mine, at Wilcoe, about a mile northwest of Gary, is a shaft operation with a steel head-frame, and when working the cages are hoisted and the coal dumped into bins direct. This is the only mine in the district generating explosive gas. The No. 3 and No. 4 seams are developed here.

At No. 2 mine, working the No. 4 seam, just west of Gary, the cars in the mine dump into a bin that discharges by a reciprocating feeder into a 3-foot Link-Belt conveyer which carries the coal through a 9′×11′ rock tunnel and up a grade of 40 per cent. The outer end of the tunnel overlaps a steel truss which has an inside width of 6 feet, that enables a man to walk alongside of the conveyer. The tunnel length is 167 feet and the truss 89 feet. It was found impossible to get height sufficient to move the cars to the tipple without erecting a hoist, should the mine cars

come to the surface over an ordinary haulage road.

About a quarter of a mile to the north of Gary is the No. 3 mine operating the No. 4 seam. There the coal is hauled by electric locomotives 2,900 feet along the hillside to the tipple.

one on the east and one on the west side of the ravine that slopes down to the Right Fork of Sand Lick Creek.

The mines have a development for 5,000 tons per day. All the coal is mined by machines, and the operations are considered the most up to date in the region. The company is

At No. 10 mine both the No. 3 and No. 4 seams are worked. On the east side only is the No. 4 seam worked, and it being but 5 feet in thickness, 2-ton cars are used. If these cars should go to the tipple where larger cars are dumped, there would be great confusion in handling

Fig. 2. Tipple at No. 4 Mine

Fig. 3. Pit Mouth, Fan, and Substation, at No. 6 Mine

At the No. 4 mine along Harman Branch, 3 miles east of Gary, the No. 3 seam is worked. The mouth of the drift is about 400 feet from the tipple, just far enough for a yard. Fig. 2 shows the steel tipple and the great drop in the elevation from the drift haulage road to the railroad tracks.

The No. 3 seam is worked at No. 5 mine. Here a draw slate of from 20 to 30 inches is encountered, which is pulled down in all main haulage and room entries.

No. 6 mine working in the No. 4 seam is the largest producing single mine along the Norfolk & Western Railroad. Fig. 3 shows the mine mouth. The coal is hauled 4,200 feet to the tipple.

The No. 7 mine is about 1 mile above No. 6 and is working the No. 4 seam.

The No. 8 mine, 2 miles southeast of Gary, along Sand Lick Creek, is a temporary operation, there being no permanent equipment installed at present. Estimates are now being made for a permanent operation.

At the No. 9 plant, 3 miles south of Gary, the No. 4 seam is being worked. The coal is from 6 to 8 feet in thickness. There are two mines,

adopting here new solid-rolled steel car wheels made by the Carnegie Steel Co. A new steel mine car is also being adopted. The body of the car is almost semicircular in cross-section, is 9 feet 4 inches long, 5 feet 8 inches wide at the top, and 28 inches deep, with a brake on the back. A new idea is put into use here with reference to brake blocks. Instead of a brake becoming useless after the wearing away of the block, a new block is substituted, which is made of cast iron and fastened to the brake arm by a clevis and pin. It assures a quick and efficient method of controlling the cars.

Owing to there being a great difference in elevation between the drift mouths on either side of the ravine, the cars from the two mines necessitate two separate dumps. Those from the east side are hauled north along the hillside and run on to the tipple as shown on the extreme right of Fig. 4. On the west side the cars are run out approximately 1,000 feet to a Phillips cross-over dump, where the coal falls into a hopper from which it is discharged by a reciprocating feeder on to a Robins belt conveyer and taken to the head of the tipple, as shown on the left in Fig. 4.

them, so the coal is dumped just inside the pit mouth, down a shaft 8 feet square and about 80 feet deep, which forms a bin over a haulage road in the No. 3 seam, and from there it is hauled to the tipple in 3-ton cars, such as are used in that seam. At the tipple of this mine a car counter is used. It was designed by Superintendent J. R. Booth, and when the car goes on to the dump it is registered. The counting device operates like a street-car fare recorder and will go to 999.

It takes six men to turn the dump without a car; therefore, it requires that many men to record a false return of the day's tonnage.

The No. 11 mine is about one-half mile above No. 10, and on the opposite side of the river. Both Nos. 3 and 4 seams are being mined and delivered to the same tipple by short tramroads. The coal at the upper seam is dumped into a chute leading past the lower dump to the picking tables, where the coal from both seams is mixed.

At the No. 12 mine, at Anawalt, about 9 miles east of Gary, the No. 3 seam is worked. The seam here is high along the mountainside, and Link-Belt retarding conveyers are used, not to prevent breakage, but

for efficient handling. The coal is dumped from the mine cars on to a picking table up on the mountainside; from there it is discharged into the conveyer constructed on a pitch of 19 degrees and which discharges the coal into another conveyer 390 feet below. The second conveyer continues 390 feet farther down the mountain on a pitch of 25½ degrees, where the coal passes into a third conveyer starting down at an angle of 31° 45′, which rounds off on an 80-foot curve to horizontal, and is 216 feet long.

THE OPERATIONS IN GENERAL

The mining machines are all room and pillar, or short-wall machines. The company operates six machines with 10 feet 4 inches cutter bars, seven with 8 feet 6 inches cutter bars, and 80 with 6 feet 6 inches cutter bars. The machines are of Sullivan and Jeffrey manufacture.

The four-entry system is adopted, the two on one side for a haulageway and a manway, and the others for airways. The entries in each pair are connected every 80 feet as required by law, but the two sets are connected only every 500 feet and closed afterward with concrete stoppings.

All drift mouths are concreted inside until solid roof is encountered. No props are allowed on the haulage roads. The custom is to take down bad roof until good roof is bared and use permanent supports.

Incandescent lamps of 50 candlepower are affixed to the roof at 150-foot intervals along the haulage roads, the object being to enable a man to walk out of danger without a light if necessary.

The mine track gauge is 48 inches in all the mines. All main haulage roads, and those having steep grades or long distances, are equipped with 60-pound rails, shorter haulageways have 40-pound rails, while 30-pound rails are used in the butt entries and 20-pound rails in the rooms, where they are laid on Carnegie steel mine ties.

Carbide lamps are used exclusively, save by the motormen and brakemen on the locomotives, who use open oil lamps. The entire haulage equipment consists of thirty-two 13-ton, and seven 7½-ton electric locomotives of Jeffrey, General Electric, and Westinghouse manufacture.

At most of the mines a revolving slate-dump car is used. This car when hauled out on the bank can be dumped in any direction.

All the tipples are of steel except at mines Nos. 3, 8, 11, and 12. The steel tipples are products of the Illinois Steel Co., the McClintic-Marshall Co., and the American Bridge Co. At Nos. 9, 10, and 12 tipples, compressed air is installed for operating the loading gates, and a big railroad car can be loaded in 1 minute. All coal shipped is run of mine.

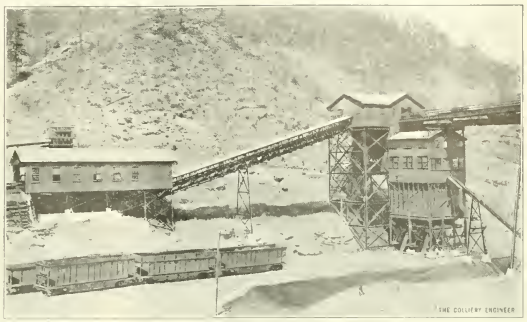


Fig. 4. Tipple at No. 9 Mine

The O'Toole mining machine, designed by Edward O'Toole, general superintendent of the company, has been tried as an experiment, and is now being remodeled so that it can be used practically. It consists essentially of picks radially mounted on a revolving shaft which is 10 feet long. The shaft moves up and down while revolving, so that it mines the entire thickness of the seam. The coal drops into a scraper conveyer which draws it to the rear. The machine in experimental tests has mined 2,400 pounds of coal per minute, and 125 tons have been cut, loaded, and disposed of, in a 9-hour shift.

Close attention is paid to the ventilation, air measurements being taken by an assistant foreman each week, by a company mine inspector every 2 weeks, and by the division engineer each month.

Each mine has from four to six assistant foremen. Each assistant

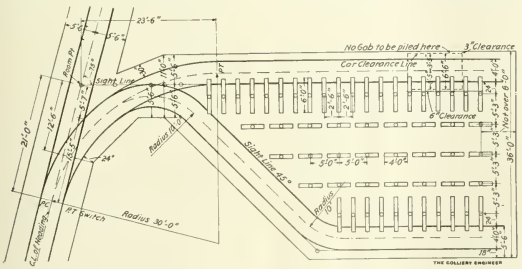


Fig. 5. Standard Plan of Room Timbering, and Track

foreman has charge of not more than 26 men. He does all the shot firing and visits each working place in his section at least five times during the day.

RULES AND REGULATIONS

Colonel O'Toole has sent to the mine superintendents and mine foremen, positive rules regarding the operation of the mines. These rules specify that in all work they must consider, first, safety; second, quality; and third, cost. They are well worth adoption at hundreds of other mines in the country. The following are some of the details:

Ventilation and Inspection.—The last breakthrough of every pair of headings, whether working or not, must have at least 12,000 cubic feet of air per minute passing through it.

On room headings, the air-current must be properly checked with canvas curtains, to cause it to circulate to the faces of the rooms. Curtains must not be more than seven rooms apart.

Assistant foremen must examine each working place in their districts, and mark each place visited with the date of the month, before allowing men to enter them. Each idle place must be examined each day, and a record of the examination made daily in a book provided for that purpose.

Before entering the mine, assistant foremen must ascertain the condition of the ventilating apparatus from the fan man or the substation man.

When the fan has been stopped for 1 hour, or more, for any reason, all places must be thoroughly examined by assistant foremen before allowing men to enter them, and a record of the examination must be made in the record book.

All permanent brattices must be built of incombustible material, concrete preferred. Temporary brattices must be of boards, well put together with all joints stopped up with cement.

If it is necessary to carry a brattice from the last breakthrough to the face of any working place, use boards and not canvas.

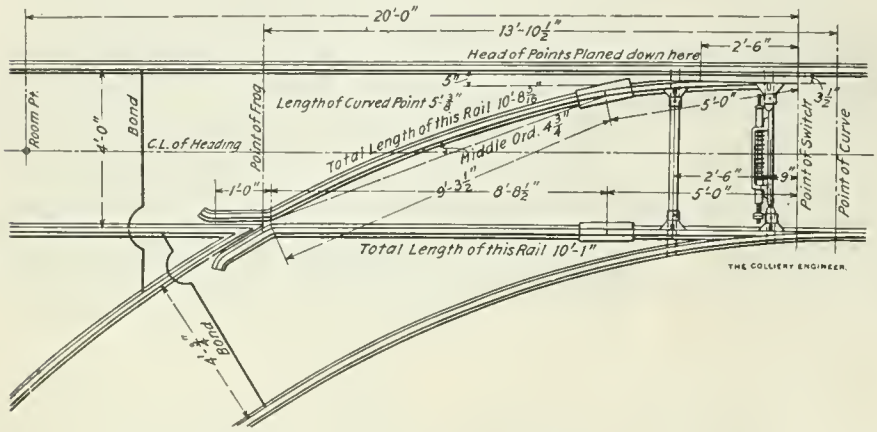


Fig. 6. Standard Plan for Room Turnout, 30 Feet Radius, and Bonding

For each shortage of air reported by monthly measurement of engineers, 10 demerits will be charged to the assistant foreman in whose district it was found. (Demerits explained later in Premium System.)

Assistant foremen must carry Pieler testing lamps when making examinations, and all final tests for gas must be made with this lamp. When an ordinary safety lamp will not detect gas, try the Pieler lamp.

The presence of dust, as well as gas, must be noted in the record book. It must not be allowed to accumulate in working places nor anywhere in the mine. All dusty places on haulage roads are to be sprinkled daily.

Explosives and Shot Firing.—No charge of any explosive, in any one hole, shall exceed 2 pounds, and the machine cuttings must be loaded in the car before the coal is shot down.

Before firing a shot, the assistant foreman must see that the place is free from gas and dust, properly posted and safe in all respects, and no one but the assistant foreman, or persons designated by mine foremen, are allowed to have possession of batteries or to fire any shot. Before firing a shot, the assistant foreman must see that all the workmen have withdrawn to a place of safety, and he, himself, must not be in the line of the shot.

Assistant foremen must not fire any shot that is improperly drilled, drilled in the solid, or improperly tamped, nor must any shot be fired within 3 hours after detecting gas in any place in the district. Where more than one shot is to be fired in any place, one shot only shall be charged, tamped, and fired, and an examination of the place must be made before firing the second or following shots. Only one shot shall be fired at a time, and the assistant foreman must carefully examine working places, after shooting, before allowing work to begin.

No explosives excepting flameless explosives, approved by the United States Bureau of Mines, shall be used, and all holes must be tamped with clay the full depth of the hole.

No shot that has missed fire shall be drilled out. A new hole must be drilled in such a manner that it will not come in contact with the explosive in the original hole. The second hole must be charged lightly. If shots miss fire, or are not fired for any reason, the assistant foreman must report the fact to the mine foreman, who must record the fact, and the reason for it, in his record book.

Augers are to be made to gauge, which must not exceed $1\frac{3}{4}$ inches in diameter, and wooden sticks used for tamping holes.

Assistant foremen must see that all caps or exploders are kept separate from explosives and at least 30 feet from them. The caps must be kept in a hole dug in the solid coal.

Shots must be fired by battery and not from machine or trolley wire.

If necessary, water the dust at the working face before shooting.

Timbering, Slate Work, Etc. Where any dangerous slate is found, the assistant foreman must take it

down at once, before work is done near it, or any one, or any trip, allowed to pass under it.

Loaders must post their working places. Proper arrangement and spacing of caps, posts, etc., is shown in Fig. 5, which must be strictly followed. (A similar arrangement is laid out for rooms of other widths.) Posts must be set in straight lines and be vertical. Cap pieces must be wedged tightly against the roof, with a wedge between the post and the cap.

Assistant foremen must not O. K. nor allow any place to be cut where posts are more than 6 feet from the face of the bottom.

All slate and loose rash must be taken down in haulage roads and manways. Places must not be cut until slate or rash is taken down to the face.

No permanent timbering will be allowed on any haulage road unless under special instructions from the general superintendent.

Airways are to be timbered in the same manner as the rooms.

Loaders must clean up slate falls in their working places, and will be paid extra for this work.

Mining machines should start to cut on the track side of the place.

Trackwork, Line Sights, Etc.—Line sights are to be carried $5\frac{1}{2}$ feet from the rib in rooms and air-courses, and in the centers of headings. The sights in all working places must be extended each day and marked on the roof by continuous chalk lines.

All haulage roads on which more than one car is hauled per trip shall be at least 5 feet high above the rail, and there shall be at least $2\frac{1}{2}$ feet clearance between any part of a car and the side of the heading at all places.

Permanent track must be kept within 150 feet of the face, and all track must be laid to line. Where grades are given, track must be laid to grade.

All rash, slate, etc., is to be kept cleaned off haulage roads.

Ties are not to be over 18 inches centers on haulage roads.

Loaders must lay the track in their working places.

See that steel ties are used for room tracks and that all straight track is laid to exact gauge—48 inches.

Permanent track must be bonded as it is laid. Fig. 6 shows standard plan of room turnouts and the bonding.

Standards for Electric Work.—The general arrangement of hangers, etc., for trolley wire is shown in Fig. 9, which must be strictly followed.

Trolley wire must be hung 6 inches outside of the rail and must be as nearly parallel to it, both horizontally and vertically, as it can be.

Where the roof is high, trolley hangers can be spaced 33 feet apart on straight track. Where the roof is low, hangers can be spaced 25 feet to 20 feet apart on straight track; the wire must always be so hung that it cannot be forced against the roof by the trolley wheel passing under it. On curves, hangers are to be spaced as shown on the standard plan, depending upon the radius of curve. Hangers must be close enough to prevent being bent sidewise by strain on the wire. Trolley wire must be pulled tight and be dead ended with an insulated turnbuckle to an anchor bolt in the roof or to a heavy post.

Where trolley wires or feed-lines cross a heading or at turnout for side tracks, each must be protected by hanging boards, Fig. 9 (*b*) and (*c*), so that neither man nor mule can come in contact with the wires.

Section line switches and sectional insulators must be installed on all trolley wire branches. They must be installed on machine and pump lines. Cable for wiring switches and insulators must be of the same capacity as the circuit controlled by the switch. Ends of the cables must be soldered solid and filed to fit the terminal, or be soldered solid into the feeder ear or terminal of the switches and sectional insulators. Cable must be kept clear of switch boxes and porcelain tubes used to bush all holes, or else holes must have $\frac{1}{2}$-inch clearance about the cables.

Trolley frogs must be used on all turnouts and each frog must have an electric lamp beside it. Frogs must be located and supported by extra hangers, as shown in Fig. 9 (*a*).

A clear space of at least 2 inches must be allowed above the trolley wire where it passes through a door, and hangers must be placed close to

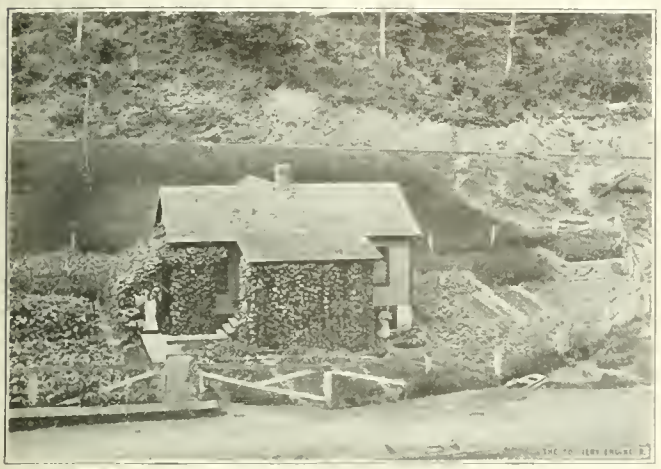


Fig. 7. Miner's House at No. 9 Works

Fig. 8. High School at Gary

each side of the door to prevent the wire from being forced up against the wood.

Joints on the trolley wire must be made with sleeves.

Feeder cables must be supported at intervals of 20 feet on barn hangers and special "Gem" insulators. Cables are to be placed 12 inches outside of the trolley lines and connected to them at intervals of 200 feet by feeder ears and solderless cable taps. Cables must be properly deadended with cable clamps and insulated turnbuckles.

Machine wire must be supported on insulators, which must not be more than 33 feet apart, and close

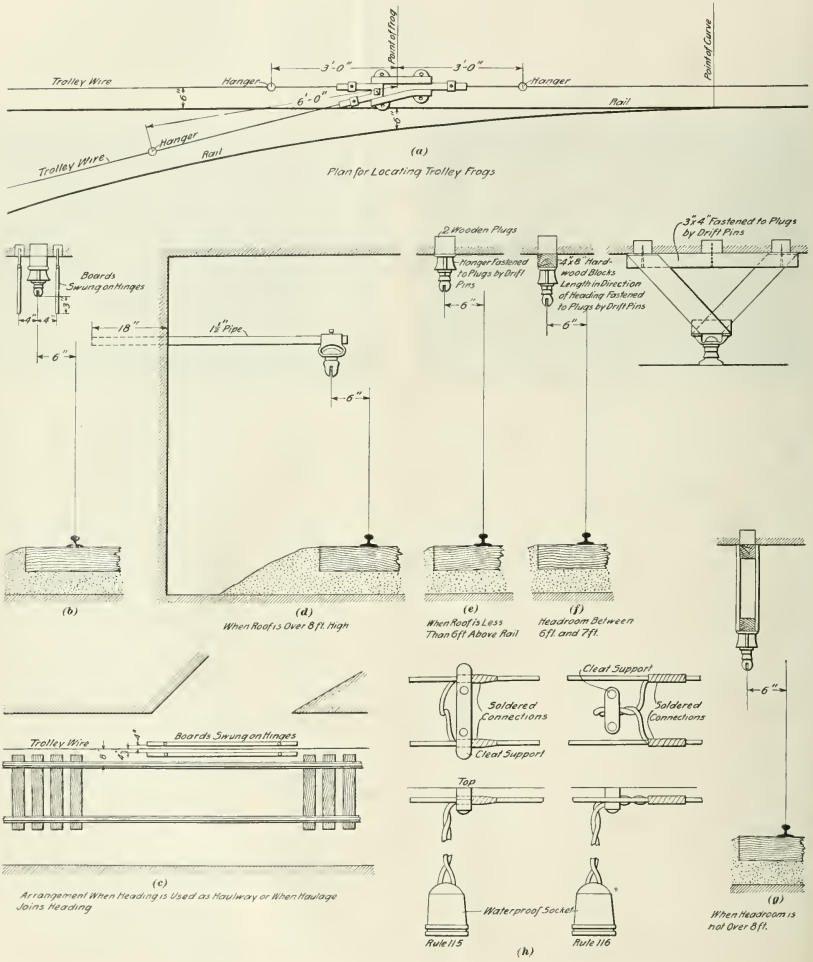


Fig. 9. Standard Plans for Electrical Work, United States Coal & Coke Co.

enough to prevent the wires from touching any posts, rib, or roof. Ground wires must be put up in the same manner as the live wires. Where the roof is good and not less than 6½ feet above the top of the rail, wires should be placed near the roof at the side of the heading, and should be 18 inches apart, the live wire being placed as close to the rib as possible. Where it is necessary to place wires on ribs and posts they must be 24 inches apart. All wires must be dead-ended on porcelain insulators. Porcelain tubes must be used around wires passing through doors or curtains, and insulators must be placed close to the ends of the tubes. Joints must be well twisted together, with six turns on each side. No hook joints will be allowed. Machine wires must be placed on the same side of the track as the trolley wire. All wires must be pulled tight and well tied to approved insulators. Machine wire should not be used in rooms less than 400 feet long. Where rooms are longer than this, the room wires must not be connected to the heading wires, excepting when the machine is in operation in the room. Each machine must carry one pair of jumpers to reach from the heading to the room wires. Insulators must be put on pins, and no wedging of insulators between wires or between wires and the roof or coal or wood will be permitted. One wire only must be on one insulator.

All tracks on headings where electric haulage is used must be bonded when laid. Holes for bonds must be clean and bright and the bond terminals forced firmly against the metal. Splice bars must be left off the joints until the bonding is inspected by the mine foreman or the superintendent. All switches on haulage roads must be bonded as shown in Fig. 6, and all track should be cross-bonded at intervals not exceeding 500 feet.

All light wiring must be thoroughly insulated from the roof, rib, or timbers, and must be tied to porcelain insulators with non-conducting material. Wire from the lamp to the ground must be on insulators, and the one from the rib to the rail be buried. No nails or staples will be allowed for fastening wire.

All insulated cables and wires must be kept free from grounds, the same as bare wires.

Pipe lines must not be used solely for pump motor returns, but, when running close to and parallel with a bonded rail, may be connected to the rail at intervals not exceeding 500 feet.

Where lights are to be installed in mines, or on damp, wet, or dusty buildings, where waterproof sockets must be used, and where a lamp is not to be carried about, the wires to the socket must be soldered direct to the circuit wires, but supported independently of them. Porcelain cleats or split knobs can be used to support a droplight. See Fig. 9 (*h*).

Where lights are to be installed that are used for portable purposes, or where lights come in contact with surrounding objects, portable cord—not lamp cord—must be used, the wires to be soldered direct to the circuit wires and be supported independently of them with porcelain cleats. Fig. 9 (*h*).

Lamp cord will not be approved in wet or dusty places. The cord must hang free from the rosette. No looping of long cords and no suspending from hooks or nails in ceilings will be permitted.

Fig. 10. Colored Quarters at No. 1 Mine

Fig. 11. Macadamized Street at No. 1 Works

GENERAL RULES

Mines will begin work at 7 A. M. and stop dumping at 3:45 P. M.

All men must be checked in and out of the mine each day.

None but employes are allowed to enter the mines unless accompanied by the mine foreman or some other official.

No person under 18 years of age shall be employed without first furnishing an affidavit of his age from his parents or guardian.

All work, excepting such repairs as cannot be done while operating, or at night, must be suspended on Sundays.

Do not allow grease, oily waste, or any other inflammable material to accumulate in pump houses, offices, or elsewhere.

Do not allow wood, old boards, ties, posts, or any inflammable material to accumulate in the mines.

Mining machine men must be in their working places or at the mine office at 4 P. M. to receive instructions from the assistant foremen.

Unless otherwise instructed, one man only will be allowed per working place.

No machinery of any kind must be allowed to operate unless all gears and dangerous portions are fully guarded.

In the vicinity of the mines conspicuous signs, all worthy of imitation, are posted, the most noteworthy of which are: "Your boss is paid to keep YOU from getting hurt. Help him all you can."

"Do not ride on mine cars or motor. You will get hurt."

"Stop this machine before oiling."

"No Sunday work allowed."

"Unless you intend to be careful to avoid injuries to yourself and fellow workmen, do not ask for employment. We do not want careless workmen."

"The prevention of accidents and injuries is a personal duty which every one owes not to himself alone, but also to his fellow workmen."

In addition to these many rules and regulations Mr. O'Toole has devised the Premium System, which he instituted in May, 1909. The system has produced wonderful results and is regulated under the following conditions:

THE PREMIUM SYSTEM

Qualifications.—1. No man shall be eligible for a premium, for any month, in any position, who has not worked in that position every working day during the month excepting one, unless he shall have been promoted during the month from one position to another, and is eligible in both positions.

It has been a custom for men in this section of the country not to work regularly, and as a number of accidents occur due to the regular foremen not working and new men being substituted, we have inserted this qualification with a view of getting men to work regularly, and thereby assist in the prevention of accidents.

2. His work must be satisfactory to his immediate superior, and, if it is not satisfactory, his superior has the right to charge him with demerits to the amount of 10 per month.

This qualification is inserted as a means of discipline, as in a number of instances some of the assistant foremen do not take sufficient interest in the prevention of accidents to attend the weekly meetings of the officials for discussion and investigation of accidents which occur.

3. This premium will not be considered as a part of the assistant foreman or foremen's wages, but is strictly in the nature of an award or a gratuity for faithful services rendered the company.

Distribution.—1. Each foreman or assistant foreman will be charged demerits for each man who is injured under his charge, each month, at the rate of 10 demerits for each minor, 20 demerits for each serious, and 40 demerits for each fatal accident.

2. Any foreman or assistant foreman who does not have any accident under him during any month will be given a credit of 5 merits, which will go toward reducing the number of demerits standing against him until all the demerits are wiped out, when he will not be given any further merits until he again receives demerits. No accident in which the victim loses less than 7 days will be considered.

We do not think it advisable to allow a man to accumulate merits, as it would have a tendency after he had accumulated a large number of merits to cause him to be less careful.

3. Any assistant foremen in whose section the company's mine inspector finds any dangerous practices or dangerous conditions which might cause accidents will be charged 5 demerits each visit he makes and finds such conditions. If he finds a section O. K. and no dangerous practices or conditions, the assistant mine foreman will be given a credit of 5 merits.

This provision is made as it is often the case accidents occur for which the assistant foreman is not directly responsible; his place might be as safe as it is possible to make it, but through carelessness on the part of one of the workmen an accident might occur over which he would have no control. In order to aid an assistant foreman who has been so unfortunate as to have an accident of this kind to get back into good standing, we have provided that 5 merits be given him if his place is kept in a safe condition.

On the other hand, an assistant foreman might permit dangerous conditions and practices on his section and still be fortunate enough not to have an accident, due not to any special care or attention on his part. We have, therefore, provided that such assistant foreman be given 5 demerits for the condition of his section.

4. The foreman's account will be charged with all demerits and credited with all merits of the assistant foremen under him, excepting when demerits are given for neglect of duty or causes other than accidents.

5. No person who has 10 or more demerits to his discredit at the end of each month shall be entitled to any premium, but, if he has less than 10 demerits, he shall receive the same premium as heretofore; namely, $5 for the assistant foremen and $10 for the foremen.

6. Any mine foreman or assistant foreman, who for 6 consecutive months is entitled to the monthly premium of $10 or $5 under the present rules, will at the end of the sixth month receive a special premium of $15 or $10, and for each month thereafter so long as his record is up to the requirements under the present rules; but when his record does not come up to the requirements under the present rules, he will have to again make a clear record for another 6 months before he is again entitled to a special premium.

7. The assistant foremen and foremen will have it distinctly pointed out to them by their immediate superior what men or jobs are under their supervision.

8. If a foreman or assistant foreman leaves the employ of the company and later reenters it, he will assume all demerits charged against him when he left its employ.

9. This basis of giving premiums may be discontinued at any time when it is decided that the purpose

for which it is intended (the elimination of accidents) is not accomplished.

Up to a few months ago the company had paid out 2,180 premiums to the value of $24,670. The result is marked. The increase in tonnage per fatal accident has been over 400 per cent. It is believed that in a few months, even that figure will be raised 50 per cent., making 600 per cent. more tonnage per fatal accident, than in 1908, the last year without premiums. The present rate of mining is approximately 500,000 tons of coal mined per fatal accident inside.

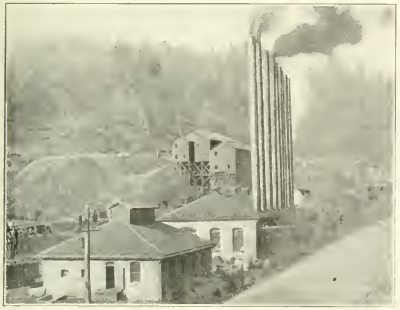


Fig. 12. Ice Plant and Boiler House, Main Power Station

Fig. 13. Cooling Towers at Main Power House

THE SOCIOLOGICAL SIDE

The first impression one has of Gary on entering the town is the large sign along the hillside on the north, which displays the slogan of the Steel Corporation: "Safety the First Consideration." Most of the town lies to the right, behind the hill (Fig. 1).

The town commissary is complete in every way. An independent store, which is in competition with the commissary, is supplied with electric lighting, etc., by the company, there being no "squashing" whatever.

The drug store and bakery is conducted jointly with the commissary, yet in separate buildings. The bakery output being about 350 loaves of bread and numerous cakes of various sizes each day.

The houses are neatly painted, there being four standard colors used, steel gray, yellow, red, and green. All the new houses are fenced, have gravel sidewalks and concrete gutters by the roadside.

The mines were opened in 1902 and in 10 years the company expended $250,000 in welfare and sanitation work at the 12 camps; this included electric lights, water lines, fencing, etc. In 1912, $69,000 were expended and the same work cost $73,000 in 1913.

The average type of houses now being erected for the miners are of six rooms, all two-family houses, and costing the company $1,700, which includes grading, fencing, wiring, piping etc. It required the excavation of 17,000 cubic yards along the mountainside at No. 9 mine to enable the company to build 35 new houses. Houses are not allowed to be less than 50 feet apart.

They are well constructed and all frame lumber is of the best quality of hemlock. All the roofs are sheathed with 1-inch hemlock or poplar boards nailed to the rafters. The rooms, halls, and closets on the first and second floors are plastered with wood fiber plaster. The woodwork is stopped and painted with three coats of mixed paint. The houses are wired for electric lights and each house has running water. These houses may be noted at the right of Fig. 11. Those erected for superintendents and mine foremen have added conveniences, such as bath rooms, etc., and cost up to $3,500 each.

The company employs sanitary inspectors at each plant who make daily inspections, superintending the garbage disposal, maintenance of fences, gates, etc. The neatness of the streets will be noted in Figs. 10 and 11. Trained nurses are employed who travel among the camps instructing the housewives in household sanitation. They care for the sick and the members of the families affected.

Great interest is taken in the care of the gardens at the various camps. Fig. 7 shows a prize garden near the No. 9 mine and is a striking contrast to some seen in more densely populated regions.

The high school, Fig. 8, is a fireproof structure with nine class rooms, an auditorium, laboratory, library, and gymnasium.

The power plant, Fig. 12, which supplies the power for all the mines and the lighting for the camps, is similar to other plants under like conditions. The equipment consists of two 400-kilowatt, and two 750-kilowatt engine-driven generators, one 1,000-kilowatt low-pressure, and one 1,000-kilowatt high-pressure, Westinghouse turbines. The steam is supplied from four 300-horsepower and five 520-horsepower Babcock & Wilcox boilers equipped with the Jones underfeed stokers. In the power house two of the engines are of

Harrisburg Foundry and Machine Co. manufacture and two were made at the shops of the Allis-Chalmers Co.

The power plant is condensing and is equipped with three Alberger cooling towers, Fig. 13. The fans at the top of these towers are operated by Pelton waterwheels driven by a centrifugal hydraulic pump located in the power plant. Hot water from the condensers is taken to the feedwater heater in the boiler house.

British Coal-Dust Precautions

Methods Employed for the Prevention of Coal-Dust Explosions in the Mines of Great Britain

*By C. F. J. Galloway, B. Sc.**

IT WAS demonstrated more than 30 years ago in Great Britain that coal dust is the principal factor in all great colliery explosions; and although, at first, the great majority of mining men treated the subject as chimerical, public opinion has gradually veered round until the number of dissentients has now become negligible.

Legislation has followed slowly in the rear but has at length reached such a stage that, if the regulations now in force are conscientiously attended to, there are not likely to be any more disasters of this kind in Great Britain.

The measures adopted fall naturally under three heads, viz.:

A. Means of preventing the deposition of dust on the roadways.

B. Means of dealing with dust that has already accumulated on the roadways.

C. Precautions to be observed in shot firing.

A. Under the first head three devices come under consideration:

1. Prevention of dust from the screens being carried down the pit.

2. The employment of dust-tight cars and slow-motion haulage.

3. Spraying the loaded cars in the mine with water before sending them out to the pit.

1. In many mines the proximity of the screens to the down-cast pit is a copious source of coal dust in the haulageways. The most obvious remedy is to erect the screens at a sufficient distance from the pit top. This is being done at all new installations, the Coal Mines Act of 1911 stipulating a minimum distance of 80 yards.

Where the screens are already in operation close to the pit, however, some other means have to be adopted.

The remedy employed in many mines is to use a suction fan to abstract the dust-laden air from the screens and screen buildings, and blow it into water, or allow the dust to settle in a special chamber erected for the purpose.

2. The use of dust-tight cars, so constructed as to prevent, as far as practicable, coal dust from escaping through joints in their sides, ends, and floors, has been rendered obligatory, in all mines not naturally wet, by the Coal Mines Act of 1911; but a period of 5 years has been allowed for the alteration or replacement of existing cars.

The use of slow endless-rope haulage, in preference to rapid haulage by other means, is being extended wherever practicable on account of the smaller amount of dust made.

3. In roadways in which there are water pipes it is a simple matter to install overhead sprinklers to damp the coal in the cars as they start on their outward journey, and this has been done in many mines, notably in Yorkshire and South Wales. In some cases these sprinklers are turned on by hand; in others, automatically by the cars themselves in passing.

In one mine a number of such sprinklers are placed at intervals along the main haulageways, and are put into operation by each car in succession depressing a certain length of rail as it passes over it.

B. For dealing with coal dust when once it has collected in the haulageways, the following measures are employed:

1. Removing the dust periodically.

2. Watering.

3. Spreading stone or flue dust over it.

4. Spreading deliquescent salts over it.

1. The systematic cleaning of the roadways is now a legal obligation. The dust is usually swept off the timbers and ledges with hand brushes, sprinkled with water, swept into heaps on the floor with brooms, and loaded into dust-tight cars in which it is sent up the pit.

This work is done either during the night shift, or at week ends, or on holidays.

In one mine in which both compressed air and water pipes are laid along the main haulageways, each column of pipes is provided at regular intervals with branches and stop-cocks, and on the water column there are standpipes reaching nearly to the roof. A simple and effective portable spraying apparatus is employed for collecting the dust at certain points on the floor previously to leading it out. A perforated pipe, long enough to reach across the roadway, is attached to each standpipe in succession, in such a manner that, when the water is turned on, the jets of water issuing from the fine holes form a water screen across the whole width of the roadway. A strong blast of air, from a hose attached to the corresponding branch on the compressed-air pipe, is then directed against all points at which dust has accumulated, and the dust, thereby raised in a cloud, is carried by the air-current against the water screen and precipitated in a damp state on to the floor.

2. The practice of spraying water on the roadways for the purpose of laying the coal dust was voluntarily adopted in many mines in South Wales more than 30 years ago; it was subsequently resorted to in many mines in other coal fields, and was made compulsory by legal enactment in Westfalia in the year 1900, but,

*Cardiff, Wales.

except in the case of shot firing, it was not compulsory in Great Britain until the year 1911.

It is applied in two different ways, as follows:

(*a*) Columns of pipes containing water under pressure are laid along the roadways. On these are branch pipes at regular intervals of from 20 to 100 hundred yards (generally between 30 and 50). Each branch is provided with a stop-cock, and terminates either in a fixed spraying nozzle or in a socket to which a flexible hose pipe with a spraying nozzle can be attached as required.

In some mines the fixed sprays are allowed to operate continuously, but as a rule they are turned on for a certain time only during the "back shift."

In mines in which a flexible hose is employed this is attached to each branch successively and periodically, and the space between every two branches is watered by its means.

In some cases compressed air is employed in combination with the water, either on the injector principle, or else mixed with the water in the fixed nozzle or hose nozzle so as to atomize the water more effectually (Martin's patent originally).

(*b*) In the absence of water pipes, water tanks are used. These vary from the primitive barrel with a plug hole near the bottom, from which, on the withdrawal of the plug, the water dribbles on to the road, to tanks provided with pumps, or rotary sprays, or brushes actuated by gearing connected to the axle.

A very common intermediate type is one which resembles the ordinary street watering cart. In this case the distributing pipe sometimes extends all around the lower edge of the tank, or is bent into a vertical circle or into an inverted U shape at the back end of the tank, the water being forced into the perforated pipe by mean of the pump with sufficient pressure to cause it to strike against the roof and sides of the roadway.

In a convenient modification of this type, which may also be used for whitewashing, the tank is a closed vessel with a valve in the top, to which a hose, connected to the compressed-air pipe, can be coupled. The space above the water can thus be filled with compressed air, which forces the water through the holes in the perforated pipe.

On roads on which mechanical haulage is employed these tanks are usually hitched on to the tail-end of the trip; in other cases they are drawn by a horse during the night shift.

In some mines wet zones of from 50 to 100 yards in length are maintained in the main haulageways, but the watering is usually done throughout.

Soft soap is added to the water in a few cases, notably in Yorkshire. This has the effect of forming a film over the surface of the dust.

3. The proposal to employ stone and other inert or hygroscopic dusts, to dilute the coal dust and render the mixture non-explosive, was first publicly advocated by Professor Galloway in an article which appeared in the *Daily Chronicle* on the 24th of June, 1896, in which he related the results of experiments he had made with dusts of chalk, clay, and salt at University College, Cardiff, in the presence of Mr. Vaughan Nash and Mr. Robson, the Chief Inspector of Mines for South Wales. On the 23d of January, 1907, he again made the same recommendation in giving his evidence before the Royal Commission on Mines.

The matter was subsequently taken up by a committee appointed by the Mining Association of Great Britain, with the result that this system of rendering coal dust innocuous has been accepted as an alternative to watering in the provisions of the Coal Mines Act of 1911, and has come into very general use throughout the country.

It has to a considerable extent superseded the use of water, being entirely free from the most objectionable feature of the latter, namely, the disintegration of the floor and roof in certain kinds of ground.

It has also the additional advantage of greater permanence, one application of stone dust being effective until a considerable further deposition of coal dust has taken place, whereas one application of water is only effective until it has evaporated, even if no fresh coal dust is deposited in the meantime.

The inert dust is usually prepared by grinding shale on the surface, but in many mines flue dust, which is already in a state of comminution, is employed for the purpose.

No satisfactory mechanical means of distributing dust has yet been evolved, although in one Yorkshire mine it is sprayed by means of an apparatus described as a modification of a whitewashing machine, of which, however, no particulars have yet been published.

After the coal dust has been thoroughly brushed from the timbers, ledges, etc., filled into cars, and sent up the pit, a car of stone dust is conveyed along the road, and the dust scattered on the floor, and thrown forcibly against the roof, sides, timbers, etc., by hand.

In some cases a sieve, about 2 feet in diameter and 6 inches deep, with fine meshes, is used to distribute it more evenly over the floor.

In others it is disseminated in the intake air by means of a blower fan, or by being dropped in front of a blast of compressed air issuing from a jet.

The intervals of time allowed to elapse between applications of stone dust vary greatly; in some mines it is applied nightly; in others only three or four times a year.

In a few cases it is applied only in zones from 100 to 200 yards long, but more generally it is distributed over the whole length of the haulageways.

In a number of mines stone dust is placed on overhead shelves, suspended from the timbers, so that in the event of an explosion happening it may be blown in the form of a cloud by the preliminary air blast, with the object of diluting the coal dust and rendering it harmless.

4. There are a number of mines, chiefly in Scotland, in which deliquescent salts (chloride of calcium or rock salt) are employed with

satisfactory results, spread either in zones or else throughout the roadways.

In a number of mines certain lengths of the main haulageways are arched with bricks and whitewashed, the space thus prepared being treated by one or other of the methods described above.

C. Before firing shots in the main roads it is usual to remove the coal dust as well as possible from the vicinity, and then to apply the same method of dealing with the remainder as is in general use in that mine.

In shot firing at the coal face special means are usually adopted.

In a few cases where there happen to be water pipes in the immediate neighborhood, a hose is coupled to these, and used to water the dust, but the methods in more general use are the following:

1. Sprinkling water from a bucket by hand.

2. Sprinkling water with a syringe.

3. Sprinkling water by means of a tank on wheels, with a hose pipe and nozzle, but without a pump.

4. Sprinkling water by means of a similar tank with a hand pump.

5. Sprinkling water by means of a portable tank with a hand pump.

6. The application of stone or flue dust by hand.

1. The primitive method of sprinkling water by hand from a bucket is still in vogue in many mines in South Wales and elsewhere.

2. A vast improvement on this is to use a syringe which the shot firer carries in his hand and fills with water from a bucket or from a tub placed at some convenient point. This very effective means of damping the dust is largely used in Scotland.

3. A plain water tank, with a hose and nozzle or spray, is used in some places, but the absence of pressure prevents the effective application of the water on any surface above the level of the floor.

4. A similar tank fitted with a hand pump necessitates the employment of two men, or one man and a boy, one to work the pump and the other to manipulate the hose.

5. In a few cases portable tanks provided with hand pumps are used, either carried by hand from point to point, and fitted with pumps similar to those used for inflating bicycle tires, or supported by straps from the shoulders, and fitted with rotary pumps.

6. In the North of England, stone dust is used to some extent in the face, although in many mines where stone dust is used exclusively on the main roads instead of watering, water is used in the face.

The shale, or flue dust, is scattered by hand for a distance of from 5 to 20 yards from the shot hole in each direction.

In some mines stone dust is placed in the mouth of the shot hole, or on a board immediately in front of it.

In one mine, in places where neither water nor stone dust is available pieces of brattice cloth are laid on the ground and weighted down in the neighborhood of a shot hole. This has the desired effect of preventing the coat dust from being raised up by the commotion caused by firing the shot.

Automatic Chute Stop

When pieces of coal from the screens high up in the breaker start down their respective chutes, they gain in momentum until they are brought to a sudden stop by impact with the coal in the pockets. When this occurs, chips of coal fly from the pieces that were in motion and sometimes from the pieces against which they strike.

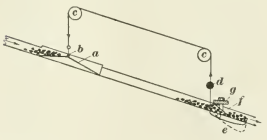


Fig. 1.

Degradation also takes place in the chutes where there are sharp turns, by the brittle pieces of coal knocking against one another; and also in the chute where some pieces of coal slide faster than others. To prevent this spoiling as much as possible, the Delaware, Lackawanna & Western Coal Co. have installed automatic chute stops which were devised by two of its employes.

These stops are effectual and simple, as can be seen by reference to Fig. 1, at the same time they accomplish the object for which they are intended. In the elevation the pan *a* is hinged at *b* so that its wings may straighten out or be at the angle shown. This pan is connected by means of a rope passing over pulleys *c* to a counterweight *d* and a pivoted stop *e*.

When sufficient coal has accumulated on the pan to lift the weight *d*, the wings of the pan flatten out so that the coal passes over them down the chute. In the mean time the weight *d* lifting lowers the lip of stop *e* and the coal behind it moves down the chute until the counterweight *d* moves downwards and raises both the basket to the position shown and the stop *e* as well; this stops the flow of coal till the pan *b* is again depressed by the accumulated coal. This action takes place every so often so long as coal comes down the chute.

At *f* there is an iron plate held in place by setscrews that play in the timber *g*. The object of this plate is to hold back the coal so that it will be fed down the chute to the stop *e* evenly, for that projects only a short distance above the inside of the chute and should all the coal be permitted to move together it would flood the stop and a considerable amount of it might pass over without coming to rest.

There are somewhat more than 500 recognized tree species in the United States, of which about 100 are commercially important for timber. Of the 500 recognized species, 300 are represented in the government's newly acquired Appalachian forests. All American species, except a very few subtropical ones on the Florida keys and in extreme southern Texas, are to be found in one or another of the national forests.

Black Diamond Concrete Tipple

A Description of an Ohio Coal Mine, the Methods of Mining Employed, and a Remarkable Tipple

By Wilbur Greeley Burroughs

THE Black Diamond coal mine is near the town of Lathrop, Berne Township, Athens County, Ohio. The coal mined is the Pittsburg, No. 8 seam, also known as the Federal Creek coal. In Berne Township, where the seam is especially well developed, it outcrops in the valley of Federal Creek and on its principal tributaries, Sharp's Fork, Opossum Run, and Marietta Run.

SECTION FROM NEFF MINE NO. 2, NEAR BELLAIRE, OHIO

	Feet	Inches
Roof coal	1	
Draw slate		10
Breast coal	2	3
Shale parting		½
Bearing in coal		2
Shale parting		1
Brick coal	1	5
Pyrites parting		1½
Bottom coal	1	3

This section illustrates the normal structure of the Pittsburg coal seam in Pennsylvania, West Virginia, Maryland, and parts of Ohio. Taken from Ohio Geological Survey Bulletin, No. 9, page 10.

The structure of the Pittsburg coal in the Federal Creek district is in marked contrast with its normal structure as found along the Ohio River in Belmont and Jefferson counties, Ohio, and in the states of Pennsylvania, West Virginia, and Maryland. By comparing the accompanying two sections, it will be seen that the usual divisions such as "Breast" coal, etc., are wanting in the Federal Creek district, and that the seam is there divided into an Upper and Lower bench, separated by a bed of shale, which, according to Bulletin No. 9, Ohio State Geological Survey, corresponds to the "Bearing in" coal, with the parting above and below, while the coal below the parting in question represents the "Brick" and "Bottom" coals, and the coal above the parting is equivalent to the "Breast" coal of the Pittsburg bed.

At the Black Diamond mine, the coal dips toward the southeast 14 feet in 4,000 feet, and the entire coal seam is mined, with the exception of from 8 to 12 inches of top coal, which is left to support the roof of entries and rooms; above this top coal there is a shale cover of from 100 feet to 300 feet in thickness.

The cleatage of the coal not being pronounced, does not interfere with driving of entries in any direction. Some clay veins in the coal make it necessary to vary the width of the pillars between the rooms.

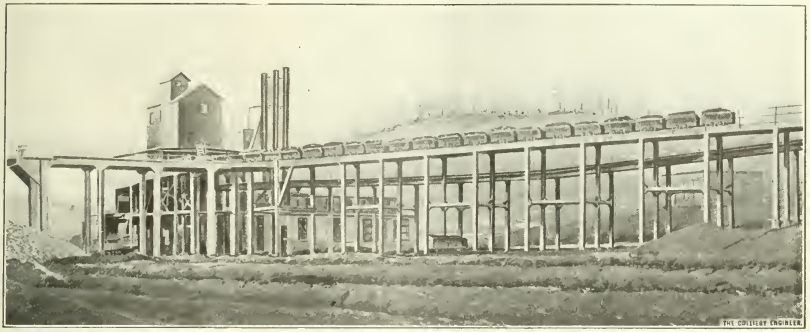


FIG. 1. BLACK DIAMOND CONCRETE TIPPLE. EVERYTHING OF CONCRETE

SECTION OF PITTSBURG COAL SEAM IN BLACK DIAMOND COAL MINE, FEDERAL CREEK DISTRICT*

		Feet	Inches	
Shale, unmeasured				
Upper bench	Coal	2	7	Total = 3 ft. 8 in.
Soapstone, or shale	Bone coal	1	1	Total = 1 ft.
Lower bench	Coal		10	Total = 3 ft. 6¼ in.
	Parting		¼	
	Coal		4	
	Parting		¼	
	Coal		9	
	Parting		¼	
	Coal		8	
	Parting		¼	
	Coal		10	
Fireclay			4	

*From Ohio Geological Survey, Bulletin No. 9, pages 10 and 73.

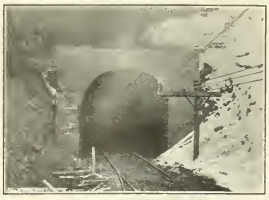


FIG. 2. MAIN HAULAGE SLOPE, BLACK DIAMOND MINE

The floor is of fireclay 4 inches thick, it being regular, with no heaving. The topography of the region is that of hills 100 to 300 feet high, intersected by narrow valleys.

Fig. 3. Concrete Slack Bin and Loading Tipple, Black Diamond Mine

At the base of one of these hills, as shown in Fig. 2, the main haulage slope of the Black Diamond mine has been driven on a 1¼-per-cent. grade. The slope is 13 feet wide by 8 feet high, and is lined with brick for 100 feet inwards from its mouth, and lighted by electricity.

The chemical analysis of the coal follows:

Ultimate	
Carbon	67.55
Hydrogen	5.14
Oxygen	14.17
Nitrogen	.95
Sulphur	4.19
Ash	8.00
Total	100.00

Proximate	
Moisture	5.78*
Volatile matter	37.43
Fixed carbon	48.79
Ash	8.00
Total	100.00

Calorific value, 6,833 calories, or 14,099 British thermal units.
*Moisture in the air-dried sample about 3 per cent.

Room-and-pillar mining is used, with double entries driven approximately on the face and butt cleats.

The main haulage entry runs east on the butt cleat. Face entries are turned every 2,000 feet to the north of the main entry, and every 1,000 feet to the south of the main entry, which make the face entries run north and south. Butt entries are turned from these face entries every 500 feet, which throws the butt entries east and west. The rooms turned from the butt entries, have north and south directions. The room necks, 13 feet long, are widened, to form rooms from 25 to 33 feet wide, 250 feet long, that have 46-foot centers, which leaves a 21-foot to 13-foot pillar of coal between the rooms. Breakthroughs are made every 60 feet, between the double entries, and every 60 feet between the rooms, and are staggered.

The coal is mined by electrically operated mining machines, there being five Morgan-Gardner, and two Jeffrey machines, which make a cut 6 feet deep in the lower bench of coal, which is then shot. In narrow places the parting slate stays up after the lower bench has been mined and the coal loaded into the mine cars, after which it is broken down, cleaned up, and the upper bench of coal is mined. In wide places the parting slate comes down with the lower bench of coal, the endeavor being to bring the slate down on top of the coal without any mixing of the two. The slate is worked off the coal and carried out, leaving the clean coal by itself. Later the upper bench of coal is mined.

For all haulage purposes, the track is laid in the center of the slope, entries, and rooms. In each trip 25 to 30 tons of coal are handled, the loaded trip traveling at the rate of 5 miles an hour. On the main haulage track, extending into the mine 4,000 feet, is used a 10-ton Morgan-Gardner electric mine locomotive; horses bring the mine cars from the rooms to the main haulage road. The weight of rails used for motor haulage outdoors and in the mine is 56-pound steel for 2,500 feet, 35-pound steel for 3,000 feet, and 30-pound steel for the balance of the distance. Tracks on which the horses pull the mine cars are of 16-pound steel.

The roof exerts no immediate downward pressure in the entries and rooms. Four rows of posts are placed in each room.

The ventilation is accomplished by means of a Crawford & McCrimmon, 18-foot, force fan, which is capable of furnishing 75,000 cubic feet of air per minute, but is run so as to furnish 40,000 to 50,000 cubic feet of air per minute. There are two air-shafts, one 6 ft.×12 ft., through which the air is forced into the mine, the other air-shaft, 8 ft.×10 ft., located some distance away, up which, as well as the main haulage slope, the air from the mine escapes. In the mine, door regulators are used.

Not much water accumulates in the mine, and all that comes in during 24 hours can be pumped out in 4 hours.

A good deal of coal dust collects in the entries, but it is kept cleaned up, and there never has been an explosion of coal dust or of gas.

The coal on leaving the mine is hauled by the electric mine locomotive, 3,200 feet, from the entrance of the mine to the tipple. On the trestle of the tipple, an automatic switch shunts the locomotive on to a track to the right, on which are the empty mine cars, when the switch automatically closes, allowing the loaded trip to proceed on the main track across the trestle to the tipple platform.

This automatic switch, which, also, is used at all motor passways inside and outside the mine, can best be understood by referring to Fig. 4. In this figure the switch is set so that the main track M is connected with track E on which the empty cars stand after being dumped; switch point A is in contact with rail Y, and switch point B is separated from rail X. The man running the electric mine locomotive uncouples the loaded cars from the locomotive just before coming to the switch points A and B. The locomotive glides on to the side track E, but just as its entire length is on track E, a steel arm projecting from the right side near the front of the locomotive, strikes lever arm L, which, through the system of levers shown in the diagram, throws the switch points, switch point A, moving away from rail Y, and switch point B, moving against rail X, so that the loaded cars continue straight ahead along the main track M, on to track T, which leads to the dump on the tipple platform. The switch points are now left connecting tracks M and T.

The locomotive couples on to the empty cars and starts back for the mine, moving along track E. As it nears the switch points, the weight of the locomotive forces the latch back into its original position, and connects tracks M and E. The empty trip has the locomotive ahead of it, and is hauled direct to the mine.

At the tipple platform the loaded cars are dumped on a Phillips cross-over dump, then move forwards by gravity to a kick-back, then move backwards by gravity, and switch on to a track at the right of and lower than the main track. Here, the empty cars are coupled together, and the locomotive is attached as stated.

The coal dumped from the mine cars, passes over a $1\frac{1}{4}$-inch screen, the lump coal going into bins or railroad cars, as desired; the fine coal going into the elevator hopper from where it is lifted 50 feet, by a bucket conveyer, and delivered to a revolving screen 6 feet in diameter, with $\frac{1}{4}$- and $\frac{3}{4}$-inch meshes, making 30 to 35 revolutions per minute and inclined at an angle of 20 degrees, which sizes the coal. Each grade of coal slides through chutes into bins from which it is loaded into the railroad cars. The fine screenings that go through the $\frac{1}{4}$-inch mesh, are used in the coke ovens when desired. The grades of coal made are lump, nut, pea, and slack.

Coal used for fuel in the power house immediately adjoining the tipple, goes from the top of the bucket elevator in the tipple, through an outside chute into bins in the power house directly over and in front of the boilers. These bins hold enough coal to supply fuel for the boilers for 48 hours. Chutes lead down from these bins, terminating a short distance above the floor of the boiler room, and 5 feet horizontally, in front of the boilers, the coal sliding downward so that there is always a neat heap of 5 to 6 bushels of coal on the floor ready for use.

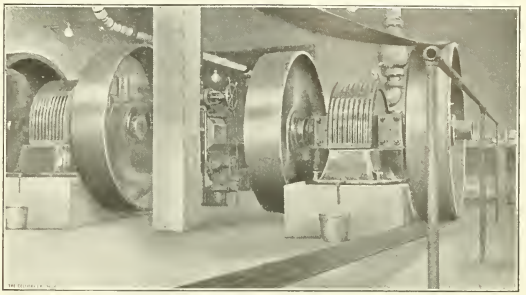


Fig. 5. Generators in Black Diamond Power Plant

By a system of butterflies in the various chutes leading from the bucket elevator and revolving screen, the different grades of coal are run to their separate bins, or are mixed as desired, by opening or closing the butterflies in the various chutes.

The fine screenings are sent through a chute to a disintegrator, where they are crushed, elevated by a bucket-conveyer into a slack bin, and from this bin are discharged into a larry car, to be used in the coke ovens, of which there are 50 of the beehive type. At the further end of the coke ovens, away from the tipple, a crusher reduces the coke to various sizes, such as chestnut, stove, and egg. An elevator and bins are also here located, and the coke is stored, each grade in its separate bin, until ready for shipment.

The advantage of having coke ovens is that whenever there is a surplus of fine coal on the market, the fine coal from the tipple is turned into coke, at other times the fine coal

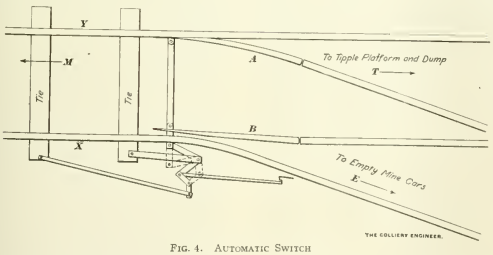


Fig. 4. Automatic Switch

is shipped and the coke ovens lie idle.

The tipple is of especial interest. It is constructed entirely of reinforced concrete, floors, roof, sides, pillars, etc., all being composed of this material. There is no wood about the tipple or the power house adjacent to it.

The tipple has been in constant use for over 2 years, but no sign of weakness has made itself evident.

In the erection of the tipple, Ray & Nold, mining engineers, Columbus, Ohio, submitted plans for a wooden tipple, and E. Elford, concrete contractor and engineer, Columbus, Ohio, using these plans, constructed the tipple of concrete.

The power plant contains three boilers in battery, each boiler 150 horsepower, made by the Union Iron Works. They are equipped with low- and high-water warning whistles. A Jeffrey 150-kilowatt generator, and a Ridgway 150-kilowatt generator, shown in Fig. 5, suffice for the electrical operation of all machinery in the tipple and mine.

On the side of a hill, just north of the power house, is a 3,000-barrel concrete reservoir, the water which it contains being pumped from a nearby creek, for use in the boilers at the power house.

The railroad connections to the Black Diamond tipple are as follows: A switch runs to the tipple from Lathrop, five-eighths of a mile distant; from Lathrop, a track runs 2 miles to Curtis Junction, where it connects with the Marietta, Columbus & Cleveland Railroad.

For information contained in this article regarding the Black Diamond property, the writer is indebted to G. W. Chambers, superintendent; for photographs, to H. L. Gilbert, treasurer and general manager of the Black Diamond Coal Co.

Canadian Mining Institute

The offices of the Secretary and the Library of the Canadian Mining Institute have been removed to Rooms 911 and 912, Ritz-Carlton Hotel, Sherbrooke St., West, Montreal, Canada.

Economical Lubrication

The Various Qualities of Oils, Greases, and Solid Lubricants, and the Uses for Which They Are Adapted—Methods of Economizing

*By W. W. Davis**

Lubrication is the introduction of some substance that will cling to or flow between the surfaces of bearings and journals of engines and machinery and keep the metal surfaces from coming in direct contact, thus preventing friction and consequent heating.

Lubricants can be divided into fluids, plastics, and solids.

To the first belong the various oils, to the second the greases, and to the third such substances as graphite, talc, mica, etc.

Where the speed is high and the pressure great, oils are the most satisfactory lubricants. They cling to the contact surfaces of the metals, keeping them apart and preventing frictional heat. Another advantage is that oils can be had of almost any density, from the thin oils to the heavy dense cylinder stocks that do not become rancid or gummy and contain no free acid.

In early days of engineering the oils used were of animal or vegetable origin, and while of good lubricating value they had their faults. They were expensive; being of organic origin they had a tendency to become rancid and the contents of free acid increased on exposure to air, etc. In recent years these animal and vegetable oils have been almost entirely displaced by mineral oils, which are cheaper and, in many respects, better lubricants. Besides, they do not change their condition on exposure or in use, provided they are clean.

The greases are more suitable for use on slow moving machinery and where the pressure is not great. There are places, however, where the speed is comparatively high, but the pressure is light, where, if the proper consistency be selected, a grease will often give excellent results. On slow-speed mining machinery it will lubricate just as well and there will be no apparent increase in friction load. In fact where the machinery is exposed to much dust, grease, if of the proper grade, will prove more efficient than oil as it will act as a seal at the ends of the bearings and other openings to keep the dust out.

Greases may be divided into two classes, the lime and potash soaps or high melting point greases, and the tallow-base, or low melting point, greases.

The first are made by combining a small amount of fatty oil into a soap by means of lime water, caustic potash or other alkali, and mixing it with a large amount of petroleum oil, such as engine oil. Such greases may be made in any degree of density and will usually have a melting point of 140° to 180° F.

The tallow-base greases are composed of a large per cent. of tallow combined with an alkali and brought to the desired density by means of vaseline, petrolatum, or petroleum oils. Such greases, owing to their large content of tallow, are of low melting point, usually about 116° to 120° F.

The high melting point greases usually require to be forced down between the journal surfaces by means of compression grease cups. The low melting point greases can often be packed in the journal boxes or directly on the bearing, as a low frictional heat will cause it to melt and change to an oil and lubricate the bearings.

The solid lubricants, such as graphite, soapstone, etc., have but a limited field as fillers or lubricants for fibrous piston-rod packings, etc.

Until recent years economical lubrication was given little attention by those in charge of machinery, the prevailing idea being that the cost of lubricants was such a small matter,

*Boston, Mass. Paper prepared for Lake Superior Mining Institute.

compared with fuel, labor, etc., that many went on the theory that, "oil was cheaper than Babbit," and used plenty of it. But with careful attention it has been found possible to lubricate machinery efficiently, and at the same time, economically.

The selection of proper lubricants depends upon the machinery on which they are to be used. If, on light running and high-speed machinery the light bodied or more fluid oils will give best results. For slow-speed machinery, the heavier bodied oils will be better. For use on slow-speed engines where the oil is fed from cups, a heavy bodied oil should be used. For high-speed work and engines where continuous oiling systems are in use, a light bodied oil should be used. Cylinder oils have for their base what is known, in the oil trade, as cylinder stock, of which there are two kinds, the light colored or filtered stock and the dark or steam refined stock, the latter being almost universally used. This cylinder stock is high in flash test and viscosity, but of itself would make a poor steam-cylinder lubricant under ordinary saturated steam conditions; for being a petroleum product it has no affinity for moisture and fails to stick to the wet cylinder and valve surfaces; it is customary therefore to compound this petroleum stock with a fatty oil, usually tallow oil or neatsfoot oil, in order that it will emulsify with the steam and cling to the surfaces. Where the steam is fairly dry, 3 to 6 per cent. is usually sufficient. Where the plant is small and the lubricating cost as well, the most satisfactory method of purchasing lubricants is to buy of a reliable oil firm, but where the cost of lubrication runs into thousands of dollars, and it is desired to obtain suitable lubricants at the lowest market price, the best plan is to purchase on specifications, stating clearly just what is needed and awarding a contract for a year's supply to the lowest responsible bidder. Specification buying is fair both to the consumer and the dealer. Specifications are simply knowing what you want and stating so on paper.

34-8—4

The usual physical tests for gravity, flash test, cold test, and vicosity, and in the case of cylinder oils, a chemical analysis for percentage of fatty oil, which are very easily made, will give any one who is familiar with lubricants a very close indication of the relative values of different oils. If one wishes to go further it is often possible to make actual service tests which will show absolutely any difference in the lubricating property of two or more oils.

If it is desired to make service tests, take a bearing that is running under constant load and speed, such as the main bearing of a high-speed engine. Place a thermometer in the bearing so that the bulb rests on the shaft, and maintain a constant feed of oil. Have another thermometer placed somewhere in the room near the bearing and out of drafts, so as to show the temperature of the room.

Commence to test when the engine is started, note the rise of temperature at frequent intervals, also that of the room; continue the test until the temperature of the bearing ceases to rise. Every bearing will in the course of a few hours reach a point where the heat is radiated as fast as it is generated. Deducting the temperature of the room from that of the bearing will give the temperature due to friction.

If the engine runs in the daytime only, the bearing will cool off during the night, then the next day repeat the test with another oil. These data may be plotted on diagram paper so as to show in a graphical manner the difference in rise of temperature with various lubricants.

While it is no doubt true that in experimental work it has been found that the coefficient of friction often decreases with rise of temperature, yet in every-day practice it is safe to assume that of two oils the one that will keep the bearing the coolest, is the best lubricant, so in tests of this kind the oil showing the least rise of temperature will be the better lubricant. Such tests can also be made in ring-oiled bearings of motors, dynamos, or shafting.

After finishing one test and before commencing another, it would be well to wash out the bearing with gasoline.

If it is desired to ascertain the lubricating value of two or more cylinder oils, take one oil and feed it at a given rate for a few days, then remove the cylinder head and wipe over the surface with a piece of soft white paper. If a good stain of oil is found it is evidence of good lubrication. If there is no stain of oil and a liberal amount has been used, it indicates either that the steam is very wet, or that not enough fatty oil has been used in compounding the lubricant.

The same tests will determine the least amount necessary to maintain good lubrication. By gradually reducing the oil feed and examining the surfaces from time to time, the proper amount necessary to maintain good lubrication can be determined. Where tests of this kind are to be made some means must be provided for easy removal of the cylinder heads.

Next to the purchasing, efficient and economical lubrication hinges on the methods of applying the lubricant. Reliable appliances for feeding lubricants will save money. There are various ways by which miners can decrease the oil bills, notably by right methods of handling and using the lubricants. In other cases, by substituting for one lubricant another and perhaps cheaper variety which will do the work as effectively, at a great reduction in cost. For instance, I have found cases where a high-priced cylinder oil was used to lubricate machinery when an ordinary machine oil would have answered better and at half the cost.

It is simply a waste of money to fit engines with a continuous oiling system unless all necessary precautions are taken to recover the oil used. At one operation where three large compound engines in one engine room used from 800 to 1,000 gallons of engine oil per month, not a drop was saved; what didn't go down the sewer was lost in wiping up.

It is surprising how little new oil is really needed to make up the loss

when proper precautions are taken to conserve it. As an instance I will say that at a certain plant in one of the suburbs of Boston, there are two vertical compound engines of several hundred horsepower each, running at 125 revolutions per minute about 11 hours per day. The oil flows in streams over the bearings, yet so well protected are they that a barrel, or 50 gallons of oil, lasts for months.

At another plant there are two single cylinder horizontal engines, about 24 in. × 48 in., running at 100 revolutions per minute. Before being equipped with an oiling system these engines used about 200 gallons of oil per month at a cost of $50. After being equipped to prevent loss by leakage, etc., the monthly consumption was reduced to less than 10 gallons. At the same time, a change was made in the kind of oil used, which cost considerably less money, with the result that these same two engines are running month after month on a cost for engine oil of less than $1.50 per month.

Another cause for loss often occurs in wiping with waste, which then goes to the boiler room to be burned. In wiping engines it has been found by experiment that a pound of dry waste will, after being used and squeezed out by hand, weigh 2 pounds, or, there is a loss of 1 gallon of oil for every 10 pounds of dry waste used. This in itself is quite an item. In most large plants it will pay to install some make of oil and waste saving machine, by means of which the oil is extracted and filtered and the waste washed, dried, and used over again.

To give an idea of what this loss sometimes amounts to, one concern was using waste at the rate of 28,000 pounds a year. Most of this waste was for wiping around the engines and machinery on which a great deal of oil was used. All of the waste was sent to the boiler room and burned. As it was heavy with oil, it is probable that 2,000 gallons of oil, together with the waste, were lost per annum.

Receiving, storing, and distributing lubricants are important factors in economical lubrication. If the plant is a large one where several thousand gallons of oil are used per year, it will pay to provide storage capacity so that all the oils can be bought in tank-car lots. In this way there will be a reduction in the price and also a saving in the amount of labor required to handle the oil.

But if it be a small plant where only a few barrels of each kind of oil are used per month, the oil should be kept in tanks so arranged that the barrels can be emptied into them by gravity. Care should be taken to see that the barrels drain out thoroughly. As the empty barrels are worth from 75 cents to $1 or more each, they are worth saving and should be kept in a cool place to prevent shrinking until enough have accumulated to make a carload. When sold, the amount received should be credited to the lubricant account.

It is customary at a large plant to have some one in charge of the oil house, to receive and store the lubricants, and issue or deliver them to the various engine rooms and departments, keeping a record of the amounts issued in a book or on a blank form provided for this purpose. This is quite as important in a small plant and can be done without great effort or expense.

In one plant the various departments are provided with cans or small tanks of size sufficient to hold a few days supply. The name of the departments to which the cans belong are stamped on strips of sheet brass soldered upon the cans. Leaky cans or cans with broken spouts tend to wastefulness. The repair man should periodically gather up all such cans and repair damages or fit new spouts before returning the cans.

No oils should be issued except on a requisition signed by the department foreman. At small plants where the amount used does not warrant keeping a man especially to look after the lubricants, the oil house is placed in charge of the general storekeeper, and opened only at certain times, half an hour or so in the morning, and the same time in the afternoon. The men come or send for their supply of oil at these times. At all other times the oil house is kept locked.

At the end of the month the amounts of lubricants issued should be totaled up and entered on a blank. The totals when multiplied by their price per gallon or pound will show the cost of each kind of lubricant used and also the amount used in each engine room and department and their cost. By comparing reports month by month it can be seen whether the cost is increasing or decreasing and in what department the differences have taken place.

By dividing the total cost by some unit of product or output such as tons, kilowatt hours, or whatever it may be, the cost of output may be determined and entered on the report sheet. There should also be a place to enter the amounts of oil purchased during the month, the number of empty barrels sold, and the amount received for them. Thus, a complete record of the lubricant cost can be kept on one sheet.

Considerable saving can often be effected by reducing to as few as possible the number of different kinds of lubricants. Many persons in charge of machinery have an idea that they must have some certain brand of oil, and that they will have all kinds of trouble if they should attempt to use anything else.

At one operation it was found that four different brands of cylinder oil, five brands of engine and machine oil, and a dozen or more different kinds or grades of grease were in use. Some were fairly reasonable in price, others inordinately high. In one engine room, the engineers had to have a certain kind of oil, in other engine rooms in the same building the engineers couldn't use this oil at all, but had to have something else. In the electric power house still another brand was called for, and the men in the pump house had to have something else. Each of the four brands had a different price. Analyses and practical tests showed that they were all of good quality, but no one better than another. A few plain common-sense tests and dem-

onstrations soon convinced the men of the fallacy of their notions, and after that one grade of cylinder oil and two grades of engine and machine oil answered every need. As to greases, it was soon shown that three kinds of grades would answer every requirement.

But the main thing in regard to economical use of lubricants is to train the hands to be careful in their use of the oil, a matter which requires constant attention on the part of the management, and where there are several plants it will often pay to have a good man take charge of this work.

Depth and Thickness of Anthracite Seams

In an article in the *Wilkes-Barre Record*, Henry C. Demming, consulting geologist of Pennsylvania, says that the lowest coal bed in Pennsylvania is under a hill south of Minersville, about 2 miles southwestwardly from Pottsville, Schuylkill County. This coal bed is 3,000 feet beneath the surface.

On Mill Creek, less than a mile eastwardly from Pottsville, there are 36 coal beds, each bed having a thickness of from 1 foot, the thinnest, to over 20 feet, the thickest.

There is one seam or bed of coal in the Mahanoy field, between 9 and 10 miles northward from Pottsville, that reaches 70 feet in thickness, but its average may be called 30 feet.

There has been no coal mined in Pennsylvania to a greater depth than 2,000 feet.

Conditions Affecting Mining

In the Bering River and Matanuska Coal Fields of Alaska—Folded and Faulted Coal Beds With Irregular Cleatage and Much Water

*By W. R. Crane**

EVERY coal field has peculiarities of its own, and it is but natural to expect that the conditions in Alaska would be different from those where earth movements have not been so extensive. The wonder is that the coal bearing formations of Alaska have not been affected to even a greater extent.

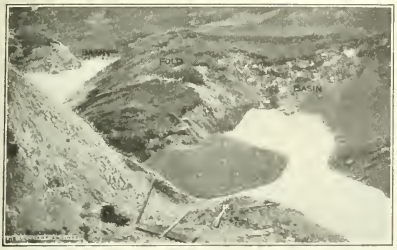


Fig. 1. Abrupt Folding—Coal Exposed in Basins

Fig. 2. Outcrop of Coal on Carbon Mountain, Showing Flaky Condition of Coal

Conditions Affecting Development. If the coal beds occur in practically horizontal positions or at moderate inclinations, their development to yield a large production economically, other conditions being favorable, is assured. When, however, high inclinations and irregular occurrences prevail, the difficulties of development are increased, and under exceptional conditions may be prohibitive.

The conditions existing in these fields that tend to make development somewhat difficult are those resulting from folding and faulting. Folding is responsible for the varying inclinations of the coal beds, for the formation of troughs and basins, and for the massing of coal. When faulting occurs, portions of beds are often displaced considerable distances, while in other cases they are entirely lost.

The development of a coal bed, dipping downward from the outcrop at a constant or slightly varying angle, presents no particularly difficult problem, but when the beds rise from the outcrop, the involved conditions are more difficult of solution. Should regularly dipping beds be faulted so that various portions lie at different elevations, then the problem necessitates a multiplication of development openings. If, however, the displacements are not sufficient distances apart to warrant separate openings, it would be necessary to connect them by gravity or engine planes.

Sufficient exploratory work has not yet been done in these fields to give definite information relative to the extent of faulting upon the coal beds, and consequently no facts are available. Judging, however, from the number and the apparent magnitude of known faults considerable difficulty is likely to be experienced in mining.

The occurrence of coal beds in basins, probably has a greater effect upon development than any other condition in the Bering River and Matanuska coal fields.

The dip of coal beds is often reversed in distances varying from a few rods to a mile or more, while on following an outcrop the dip may be observed to gradually change until it is reversed, as shown in Fig. 1.

*Dean of the School of Mining, Pennsylvania State College.

The occurrence of coal beds in basins is neither novel nor exceptional but when combined with counter folding, irregular thickness of beds and faulting, the geological conditions become unusual and involved. In this case also little definite information is available upon which to base conclusions except that which is gleaned from an examination of surface indications; but while such observations are merely superficial they must be given due weight, as the conditions they represent once existed considerable distances below the surface and have been brought into position for inspection by extensive erosion. They are, therefore, indications of representative existing conditions.

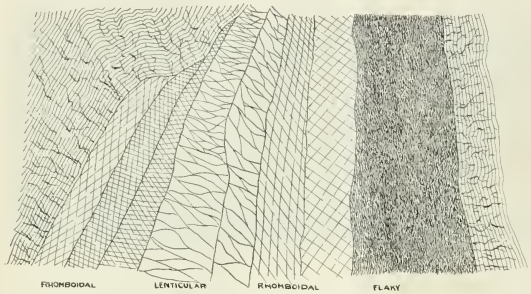


Fig. 3. Section of Coal Bed Between Shale Walls, Showing Lines of Fracture or Cleavage Planes

Conditions Affecting Mining.—The coals of the Bering River and portions of the Matanuska coal fields are badly crushed and often to such an extent that the mining and the subsequent handling of the coals would be expensive; besides, a large production of small coal would result. To meet these conditions and obtain markets, coking and briquetting seem to be the most feasible processes to adopt. Either one of these processes would place the excellent fuel values of these coals on the market in competition with the coals of other fields.

The occurrence of cleatage in practically all coal beds is a natural and desirable condition and one which is readily taken advantage of by the miner in developing and mining.

There is, considerable difference between the cleavage, or cleat, occurring in many portions of the Alaskan coal fields and that of other fields where the coal beds have not undergone such extensive distortions. Instead of one or two well-defined lines of cleavage being maintained throughout considerable areas, these coals are usually separated into bands or zones in which the lines of fracture vary both in distances apart and in direction, no apparent relation existing between the different zones although occurring side by side. The zones are apparently due to a differential action between the different portions of a coal bed, resulting in a slippage of one part upon another, and to the stresses accompanying the folding of the beds; however, whatever the cause, more or less internal fracturing in different directions has occurred as shown in Figs. 3 and 6. Further, the peculiar network of fractures often occurring, instead of the one or more well-defined sets of parallel planes, also points to excessive pressure accompanied by internal movements in the mass of the coal, as in Figs. 2 and 3.

Incipient fractures which exist in what are apparently solid masses of coal, cause the coal to degrade, and are responsible for the production of much fine coal in mining and shipment.

A common occurrence noted in sections of coal beds paralleling the dip, is the division of the coal into layers by planes running approximately parallel with the top and bottom rocks, which in turn are crossed by two other sets of planes forming angles of 45 degrees to 60 degrees with one another. These joints and planes can be observed in beds paralleling both dip and strike. In such cases the bed is broken into blocks varying in sizes from 1 to 12 inches, which in turn can be again and again subdivided by slight blows. So pronounced are these lines of fracture that often masses of coal weighing 25 pounds or more will fall from the vertical face of outcrops, and then break into numerous smaller pieces.

Some of the coal beds in the Bering River field are in lenticular masses which also readily break up into smaller fragments of similar shape, while occasionally zones occur in which the parallel and lenticular arrangements lie side by side as in Fig. 3.

Obviously such conditions would permit mining to be done wholly by pick work, but the production of fine coal would be excessive, and where soft top and bottom rocks occurred the fine coal would mix with the waste and render an otherwise excellent coal practically worthless. Further, the coal being loose and slippy does not stand well in pillars or support horses, bells, nodules of shale and pyrite, or other irregular occurrences found in the coal beds, thus adding to the difficulties and dangers of mining, as shown in Fig 8.

Lack of any definite arrangement of the lines of cleavage renders it impossible to take advantage of them in planning a mine. There are, however, certain localities, particularly in the Matanuska field where the normal arrangement of cleavage lines shown in Fig. 4, occurs and where advantage can be taken of them as in other fields.

The occurrence of small layers of shale, sandstone, or bony coal in the coal beds is as common and universal as the occurrence of the coal itself; practically the only difference that distinguishes this field from others is the frequency and irregularity of the partings.

Some coal beds both in the Bering River and Matanuska fields are badly broken up by numerous partings, thus frequently rendering them difficult to mine and necessitating extensive hand picking in order to put the coal in the proper condition for the market. Further, the partings are occasionally so irregular in thickness and so variable in their occurrence in the coal beds that they often assume the character of rolls pinching out the coal or reducing it to an unworkable thickness.

The principal difficulty, however, is experienced when the partings are of such thickness as to divide the coal beds into benches, requiring that they be worked in separate operations. With moderately thick beds this would present no serious disadvantage, but with the thinner ones the cost of mining might be rendered prohibitive by such occurrences, or if not prohibitive it might necessitate the production of a large proportion of small coal, thus reducing the value of the product.

Probably the most important consideration affecting mining operations in these fields is the lack of continuity and the irregularity of the deposits; lack of assured permanency is responsible for the element of uncertainty of adequate returns on the investment and constitues the mining risk. The risk of failure to maintain estimated output is at present reduced to a minimum in coal mining, owing to the precautions that may be taken to prove the value of a property before beginning operations. It is absolutely essential then that great care should be taken in the preliminary work on a coal property, for through lack of it many failures have occurred, even in old and well-known fields.

The folded and faulted condition of many portions of these fields, with resulting squeezed and expanded portions of coal beds and displacements varying from a few feet to several hundred, tend to place them in a class by themselves with regard to the precautions that must be taken to determine the condition and extent of the coal beds outcropping at given points. This can be demonstrated by citing an instance in the Bering River field where a 17-foot coal bed outcrops at an elevation of some 1,700 feet and stands directly on end. The line of outcrop has become the course of a small stream, thus making observation easy. Approximately 100 feet below the outcrop this bed has contracted to 9 feet 6 inches, while at a distance of 250 to 300 feet, below on the mountain side only 6 feet of coal remains. There are numerous instances in both fields, particularly the Bering River, where coal has been massed into a body several times the thickness of the original bed, or reduced by squeezing to a fraction of the original size.

Not the least of the difficulties which will result from such contortions is the change in methods of mining necessary to meet them and the disturbed and weakened state of the associated rock formations.

Any estimate made then on the assumption that the coal beds maintain a uniform thickness for considerable distances both horizontally and vertically is subject to serious error, and any attempt to do so would be of little value until exploratory work, particularly by drilling, has furnished some definite information upon which such estimates can properly be based.

Conditions Affecting Support.—The conditions affecting support of mine workings exist both within and without the coal beds, and while they are due in large part to the kind of top rock, yet the occurrence of irregularities in the top rock and in the coal has an important bearing upon support. Further, subsequent action such as weathering, folding and faulting, intrusions of igneous material, etc., increase the difficulties of maintaining mine workings.

Fig. 4. Lines of Cleavage on Outcrop of Coal, on Chickaloon Creek Matanuska Field

Fig 5 Masses of Clay, Shale, and Pyrite, Broken from Horses and Nodules in the Coal Beds

Fig. 6. Zones of Coal into Which Bed is Subdivided

While in portions of the Bering River field the top formations are excellent, yet there are many localities in which the reverse is the rule. From all indications poor top rock is probably one of the most serious conditions affecting mining that will be encountered in both of these fields.

There is a particularly soft shale occurring in parts of the Bering River field which is broken into

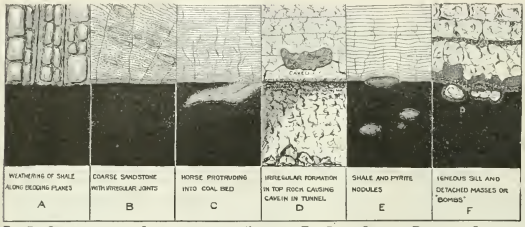


Fig. 7. Occurrences of Irregularities in Coal and Top Rock, Showing Effect on Support

blocks of varying widths by numerous joints. Weathering action along both joint and bedding planes, as shown in Fig. 7 *A*, forms concentric layers of disintegrated rock which spalls off and falls, thus constantly weakening the formation and throwing more and more dead weight upon the supports. This disintegrating action, while observed in outcrops, has also been noted in drifts and tunnels and will undoubtedly occur wherever this formation is exposed to air and moisture.

At several localities in the Matanuska field a coarse, loose grained sandstone occurs, which is composed of thin, irregular layers enclosing numerous elongated masses of harder material. This sandstone is further broken by prominent joint planes, which are irregular both with respect to distance apart and direction, cutting across the bed and breaking it into blocks. Not only does this sandstone disintegrate rapidly, but there is also danger of large wedge-shaped masses breaking away and falling, as can be seen in Fig. 7 *B*.

Often associated with the shale and sandstone formations and other kinds of top rock, are masses of unconformable shale and clay commonly known as "bells," "pots," or "kettles." Fortunately there are apparently few localities in these fields in which such irregular and dangerous formations are to be found.

While horses of shale and pyrites often assume the form of bells and rolls, yet they are usually quite distinct, and occur as large irregular masses of foreign material projecting into the top or bottom formations. In the Bering River field they frequently occur wholly in the coal bed and consist of highly bituminous clay, shale, and pyrite. Such an occurrence is shown in Fig. 7 at *C*, and was observed in a coal bed standing at an inclination of 70 degrees. In Fig. 5 are shown portions of such masses after being broken up and removed from the mine.

The removal of large masses of such material would add considerably to the expense of mining, and would probably, particularly in development work, lead to the miner working around them, thus making irregular lines of haulage and destroy the orderly arrangement of the workings.

A peculiar occurrence of waste material, probably silicified wood, is often found in the coal beds as well as in the top and bottom rocks of the Matanuska Valley. It is a very hard material although rather friable, and has a comparatively smooth wavy, undulating surface. There is apparently little or no adhesion between this material and the enclosing coal and rocks, as shown in Fig. 7, *D*, so that when occurring within a few inches or even several feet from the mine workings, it will frequently cause large masses of the material below it to fall through lack of support. As there is little or nothing to indicate its probable occurrence, it constitutes an extremely difficult and dangerous element to contend with in the support of workings. When occurring in the coal beds it is dangerous, through promoting falls, and adds materially to the expense of separating from the coal and handling.

The nodules of shale and pyrite more or less spheroidal in form and varying from a few inches to several feet in diameter, are very abundant in the Bering River field, but are comparatively rare in the Matanuska field. These nodules occur in practically every part of the coal beds, even being embedded in the top and bottom formations. In any position they are extremely difficult to handle and are a menace to life and limb. There is practically no bond between these nodules and the coal or rocks as shown in Fig. 7 *E*, and being extremely smooth they fall out even before they are actually encountered in breaking down the coal. Further, they are difficult to break when removed from the coal and consequently are a source of extra expense.

When, as often happens, the nodules are along the top rock, it would undoubtedly be preferable, provided the coal beds were of sufficient thickness to warrant it, to leave enough coal unmined next to the top rock to wholly, or at least partially, support them. In this case light sets and lagging would readily support the workings, particularly the entries and gangways.

Detached and more or less rounded masses of igneous material, injected into the coal from intruding sills, as shown in Fig. 7 *F*, radically different from the nodules mentioned, are similar from the standpoint of occurrence and the means necessarily employed to remove or maintain them in position by proper support.

There is furthermore an additional difficulty with these detached masses of igneous sill or so-called "bombs;" namely, they are surrounded by

layers of coal more or less changed to coke. The volatile and combustible matter has been largely driven out of this coal with a consequent loss of its cohesive strength, and being largely columnar in structure it is badly broken. This natural coke crumbles away as rapidly as the enclosing coal is removed, permitting the igneous material to fall or rest its dead weight directly upon the supporting timbers below.

The igneous sills, while probably nearly as strong as the ordinary top rocks, differ radically from them in their effect upon mining and support of workings. In the first place the line of contact between the sills and coal beds is irregular, which would require leaving considerable unmined coal next the top, or the placing of cribbing between the sills and lagging to give adequate support. In working coal beds of considerable thickness the former method would probably be employed, while with thin beds cribbing or other special support would be necessary. Further, in many instances the sills are badly broken, having a roughly columnar structure, which, particularly with thin sills, would cause them to have no great supporting strength in themselves, and owing to the badly burned condition of the rock occurring directly above them there is practically no bond. This is particularly true where the sills have been intruded between beds of shale and coal, the shale being so badly burned and disintegrated as to have no strength, its whole weight lying as a dead load upon the sill below.

Still another serious difficulty may be noted in connection with the sills, namely, the crossing from one bedding plane to another, either by the main body of the sill or by branches forming dykes. This is undoubtedly of unusual occurrence, for from the very nature of the sill it follows along the line of least resistance and consequently follows bedding planes. The traversing of rock strata occurring between coal beds as well as the top and bottom formations may seriously effect the condition of the strata, presenting obstacles to the driving of entries and the general development of a mine. The support of the broken strata would in itself be a difficult task.

Conditions Affecting Drainage. Owing to the excessive rainfall, in the Bering River field, the problem of draining the mines will require careful consideration, and provision

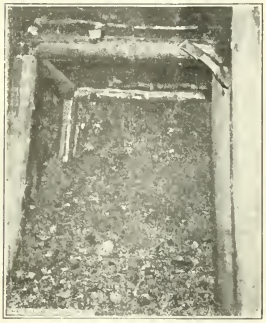


Fig. 8. Coal Running Into Tunnel From Bed Encountered

for dealing with large quantities of water will be an important feature of the layouts.

The dense layer of moss covering the mountains practically from base to the summit prevents the water rapidly draining off and permits it to enter every crevice and porous formation. The water will then ultimately appear in the mine workings and in quantities depending largely upon the extent of the bed or beds worked. The quantity of water encountered in the short tunnels and drifts already driven demonstrates that facilities for handling large volumes of water will be absolutely necessary when such lines of development are extended. Both top and bottom rocks of the inclined coal beds, as well as the coal, are often saturated with water, while at certain points where the rocks have been badly crushed the water issues in streams.

The occurrence of the coal beds at high inclinations and frequently standing vertically, naturally increases the quantity of water entering the workings through the outcrops on the mountain sides which tend to intercept much of the water draining from above the line of the outcrops. Further, the excessive folding has so fractured the top and bottom formations that the accumulation of water in the rock masses of the mountains is very large. Another cause contributing to excessive groundwater is the extensive faulting that has occurred in certain localities.

Owing to the ruggedness of the country and the necessity of opening the mines largely by tunnels and drifts, the drainage problem will be less serious than would be the case were it necessary to employ slopes and vertical shafts. Where the portions of the coal beds lying below the level of the main openings are to be worked, the bulk of the water could be intercepted and discharged at that point, thus necessitating the pumping of but a comparatively small amount. If the main openings were situated at points some distance above the natural lines of drainage, additional openings might be driven wholly for drainage purposes thus maintaining a gravity system throughout the mine.

Summary.—While special emphasis may seem to have been given to conditions adversely affecting mining operations, much might be said regarding conditions favorable to mining. It is only the exceptional conditions that need to have attention, the ordinary conditions need no mention as they can be readily handled. However, owing to the effect of extensive earth movements, occurrence of igneous intrusions, and other conditions attendant upon and resulting from such disturbances, these fields are in many ways exceptional and therefore deserve special consideration.

The conditions that particularly affect mining operations are summarized as follows: (1), badly broken coal and irregular arrangement of cleavage planes; (2), bad roof, resulting from weak top rock, igneous intrusions, and extensive folding and faulting; (3), occurrence of numerous irregularities both in

the coal beds and the associated rock strata, such as horses, bells, nodules of shale and pyrite, etc.; (4), numerous and irregular partings of shale and sandstone; and (5), conditions that form water bearing strata.

Many of these adverse conditions can readily be overcome, and experience in operating in the field will undoubtedly suggest solutions for other apparently difficult conditions. That these coal fields will be developed and worked successfully there is no doubt, and they only await the advent of experienced operators.

Uplift in West Virginia

The coal operators of West Virginia are financing a campaign for the education and social advancement of miners and mine laborers. Dean Jones, of the School of Mines at the State University, has prepared the plans, and much has been done already by the operators. John Laing, former chief of the State Department of Mines, states that clergymen of all creeds, and both white and colored, are being engaged at the suggestion of the miners, and paid by the operators to promote the work, and their influence is beginning to be evident, particularly among the children of the mining communities. The Young Men's Christian Association is also doing a great work in the mining towns, and the operators are aiding in the construction of their buildings. It is expected that within a few years Y. M. C. A. buildings will be found at all the mining camps in the state. Hospitals for the care of miners and their families are also being built by the operators, and the miners are expected to contribute 25 cents per month each toward their maintenance.

In concluding his statement, which is of interest in many ways, Mr. Laing says:

"Taking all these things into consideration, we have reason to believe that West Virginia is now leading all coal mining states in an effort to make employes as comfortable and as happy as possible."

The Longwall Method of Mining

A Description of the Method and Its Advantages—Conditions Under Which Its Use is Advisable

*By Alexander Sharp**

THERE are three methods by which coal seams are developed; namely, by shafts, slopes, and drifts. A shaft is sunk to win a particular part of a coal bed that cannot be economically worked or reached by drifts or slopes. A seam of coal that outcrops in a valley or on a mountainside can usually be won most economically by slope or drift.

FIG. 1

When a coal seam has been reached by one of these methods, and the necessary exploration work has been done to ascertain the thickness, the nature of the coal, the dip and strike of the formation, and the properties of the roof and floor, the proper method for the extraction of the coal must then be determined.

A seam of bituminous coal 1 foot thick contains approximately 1,505 tons of coal per acre. As it is the aim of the mining engineer to extract the maximum amount of coal per acre with the greatest economy and safety, the development of a new mine is a matter requiring experience, knowledge, and judgment. In making a choice of methods every possible condition affecting coal mining should be fully considered. Every field presents special problems, and even different mines in the same field can seldom be operated alike; while the physical conditions of two seams in the same field or basin may vary so materially as to necessitate different methods of working.

The two general methods of mining coal are known as longwall, and pillar and stall, and the modification of these methods.

*Vancouver, B. C. Transactions Canadian Mining Institute, 1913.

In considering possible methods of working, the following conditions are to be studied:

The topography of the coal area; the proximity to sea, lake, river, or swamp; the dip of the strata; the nature of the roof and floor of the coal seam; the depth of the coal seam from the surface; the hardness of the coal and rock seams in coal; the proximity of other coal seams and workings; the faults, dikes, and dislocations of the coal field and district.

THE LONGWALL METHOD

The longwall method of mining is said to have been first introduced in the working of the Blackband Ironstone seams at Andrie, Scotland. Here difficulty was experienced in working the hard, low, iron seams by pillar and room, and the rooms were widened to reduce the pillar work; hence the roof had to be supported by artificial pillars, and "gob" or "waste" roads formed. The wide rooms became known as the "longwall." From this elementary beginning, longwall has come into very general usage, and in Great Britain it is employed to a greater extent than all other methods combined. It is most successfully conducted under the following conditions: A good roof and floor, a hard coal seam under 6 feet in thickness, and where the dip of the seam is not more than 30 degrees. These ideal conditions cannot always be obtained, and, as a matter of fact, longwall is adopted under widely diversified conditions of roof and floor, dip and rise, and the thickness of the seam.

The principal object in working any seam of coal is to win, in the best condition, the largest quantity of coal with the greatest safety, and at the least cost. It appears to be officially recognized that the loss of coal in longwall mining is not more than 10 per cent. of the whole. Mr.

James Barrowman stated that in Scotland, "the loss on an average from bad working was only 2½ per cent. on a total output of 37,507,957 tons; the loss from pillar and room was 3.77 per cent.; and from longwall .11 per cent."

Some of the advantages of longwall over pillar and room are:

The roof pressure reduces labor and blasting; less dust is made in longwall; the mine is generally more moist in longwall, and consequently the likelihood of a dust explosion is reduced; ventilation is made easy; fewer roads are required for a given amount of coal; the percentage of round or lump coal is greater than in pillar and room; the coal is not deteriorated as is pillar coal.

The two general systems of longwall are termed advancing and retreating. In the advancing system the coal is won on the primary attack from the opening toward the boundaries. The space from which the coal is mined is packed with debris to prevent any sudden subsidence of the roof strata, which would close the roadways required for conveying the coal from the working face to the shaft bottom. This built-in space is termed the "gob" or "waste," and the roadways are termed "gob roads."

An important part in longwall working is the packing of the "gob." A uniform settlement of the roof is required in order that the proper roof pressure may weigh upon the coal face, as shown in Fig. 1 and assist in mining and so keep the cost of labor at the face as low as possible.

Of the two systems of longwall, the advancing is in more general use; but the retreating system is at times adopted when the roof is strong and the floor weak.

Scotch Longwall Advancing.—Fig. 2 represents a system of longwall suited to working thin horizontal seams. A modification of this system was adopted in the thinner portions of the Wellington coal field, the property of R. Dunsmuir & Son, Victoria, B. C. The hard bituminous coal bed, 250 feet below the surface had a soft roof and a hard floor. The sides of the gob roads were built of split logs, about 3 feet long, and debris packing obtained from the workings and from brushing the roof of the roads. In the blasting operation at the face, about 2 ounces of powder was used per ton of coal recovered. Sixty per cent. of lump coal was obtained, and 40 per cent. slack; while practically no coal was lost in mining. The sketch also represents, in a general way, the system of mining the thin level seams of Scottish coal fields at depths of from 50 feet to several hundred feet.

Fig. 3 represents a method of longwall at a Scottish colliery, in Fifeshire. The seam is 5 feet 6 inches thick, with a 5-inch rock parting in the center. It is 450 feet from the surface, and has an inclination of from 20 degrees to 30 degrees.

Shaft Pillar.—The size of a shaft pillar must be given special consideration if the longwall method is to be adopted. Only narrow excavations in the coal for roadways are made through the pillar, and as soon as the predetermined boundaries of the pillar are reached, the longwall is commenced. In determining the size of a shaft pillar the details requiring consideration are:

The depth of the shaft from the surface; the angle of the strata; the strength of the coal; the nature of the roof and floor.

In practice a good size for a shaft pillar is 120 feet square for a depth of 300 feet, with an additional 20 feet for every 60 feet increase in the depth of the shaft. If the seam is inclined, the size of the pillar is increased on the rise side of the shaft, while that to the dip side is made the same as it would be in the case of a flat seam. In normal circumstances a shaft pillar of a diameter equivalent to the depth of the shaft is a good rule to follow.* At the mine in question Fig. 3, the block of coal left as the shaft pillar was equal to 1 yard on each side of the shaft for every 6 feet of the shaft in depth. No pillars were left along the main roads, as it was decided to allow the roof to settle on the gob packs and props. After the first break in the roof the roads were easier to maintain, and there was no pillar coal to be lost by crushing.

*See Discussion.

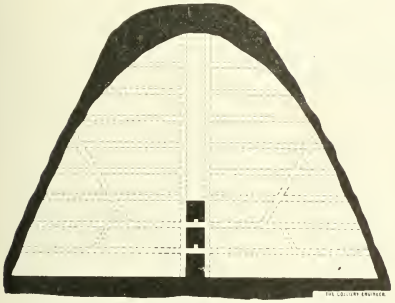


Fig. 2. Method of Working Flat Seam

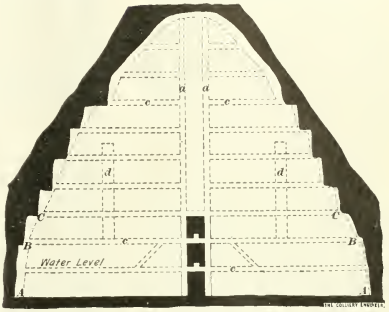


Fig. 3. Longwall Working on Pitch of 25 Degrees

The dotted lines represent the gob roads. The headings *a* are driven up the full pitch of the seam, 10 feet wide and 8 feet high. The levels *c* are advanced across the pitch. In the cut the space between the gob and the irregular black line represents the working face, and the headings and levels are called "cutting places." For haulage and drainage purposes the levels and side roads are driven at a grade of about 1 foot in 180 feet, or 1 foot in 200 feet from the shaft, that being the grade at which outgoing and incoming cars are best handled. Water will flow on a grade of 1 in 240, but for rough underground ditches 1 in 180 is the most suitable grade. The new headings *d* are made through the gob, to the full pitch of the seam, for the purpose of cutting off the gob roads about every 300 feet. Headings *a* are self-acting inclines, operated on what is known as the "cut-chain system" of haulage. The miner's assistant, or the contractor's trammer, pushes the loaded cars along the side roads *c* to the headings or cut-chain inclines, which are double tracked. One man attends to coupling and uncoupling the cars, while another attends the brake of the drum or wheel. The cars descend to the level road and are then hauled to the shaft bottom. This cut-chain system of incline haulage is an inexpensive one and the wonder is that it is not in more general use in this country.

If the coal is strong and hard, it is often best to advance the working face at right angles to the cleavage plane, and if the coal is soft, it is often best to advance the coal face parallel to the line of strike. There is always one direction in which the coal breaks easiest and produces the largest percentage of lump coal. In Fig. 3 the coal is being mined along the strike and even though the coal is hard, it was found that the roof pressure acted best on the face when the coal was mined in this way.

In Fig. 4 is shown the pack walls and gob roads, and also the method of breaking away longwall from the pillar.

Objection may be raised to this method of breaking away longwall directly from the shaft pillar, and not allowing any pillar protection for the main haulage roads. Experience has shown that pillars left to protect headings and main levels do more harm than good. The canti-

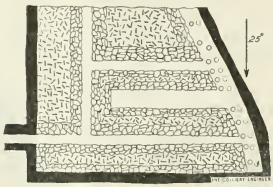


Fig. 4

lever-like pressure of the subsiding strata "rides" over the pillars into the main roads, making it difficult to maintain them in order; whereas, in the case of a working opened out like that in Fig. 3, after the first break of the roof, and the repair to the roadways, usually very little trouble follows. Pack walls should be built at least from 6 to 12 feet wide, and they cannot be too well built. If any vacant space be left it should be in the center of the gob and parallel to the gob walls as shown in Fig. 4, thereby inducing the greatest subsidence at that point. In this way less pressure comes on the pack walls and roadways. The pack debris is obtained from the

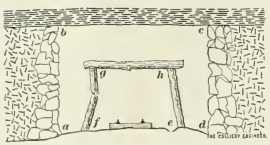


Fig. 5

undermining of the seam, rock partings in the coal, and the brushings from the roof of the roadways. There is generally sufficient building material to be obtained from these sources; however, in case of shortage material must be brought from other parts of the mine or from the surface.

All important corners of roadways are built of wood pillars or cogs. The work of brushing the roadways and building the broad packs is usually done by contract. The contractor's agreement usually demands the roadways to be of a stipulated height and width, and the walls along the sides of the roads to be built for a given sum per linear foot. The object is to let the roof subside slowly in order that the descending weight may not crush the pack building. The first break in the roof, after a seam is opened by the longwall method, is an anxious time for the management, but after the first break, and the roadways have been properly retimbered, there is little cause for anxiety, as the roof bends and subsides in a very quiet manner.

The length of the walls depends on the thickness of the seam. A seam from 3½ to 6 feet thick would have a wall of from 40 to 60 feet in length. Thin seams of from 1½ to 2 feet in thickness would have longer walls. In the workings represented by Fig. 3, the walls were 60 feet long.

Double-tracked roads are made from 10 to 12 feet wide; and 8 feet high; while the main level roads are driven 9 feet wide and 8 feet high. The ordinary side or gob roads are 8 feet wide and 7 feet high.

Longwall roads shrink to less than half their original size, as shown in Fig. 5, where *a b c d* shows the road in its original form, and *f g h i*, shows the size of the road after subsidence. When the roads become too low and too difficult to maintain, they are cut off by new cross-headings, or slants, and abandoned.

What is known as the "face" is the space between the gob and the coal walls, which is from 6 to 9 feet wide. Two rows of props, with caps, are set along the face at right angles to the roof and floor. The props are from 4 to 6 inches in diameter and are set into the floor about 1 inch to prevent them from being displaced. The cap on the top of the prop is 15 inches by 9 inches by 1½ inches, and is set lengthways to the right angle of the slips or fissures in the roof.

After a working place has been timbered, undercutting is commenced. As this operation proceeds, the face of the coal is spragged. This is a necessary precaution to avoid danger from a fall of coal. The undercut is made either in a soft clay floor, or in the under part of the coal. In former years this undercutting was made by a miner with a hand pick, but it is now successfully done with coal-cutting machines. As the undercutting proceeds, the pressure of the roof comes on the undercut coal and breaks it into slabs or blocks, which are ready to fall when the sprags are withdrawn. These blocks, or slabs of coal are termed the "break" or "web" of coal. In Fig. 3, commencing at a point A, the coal is mined toward B, likewise from B to C, and so on, until the ends of the breasts or faces have been reached. The shearing or perpendicular cutting done at A opens the "web" for the whole line of face. The success of longwall work greatly depends on the regularity in which the web of coal is worked from day to day.

In Fig. 6 is shown a 7-foot seam divided in the center by a 2-foot band of rock. The seam is worked longwall. The bottom part is first mined for a distance of 10 or 12 feet. The 2-foot band of rock is supported by props, which are afterwards drawn, allowing the rock to fall, and this is built into the gob.

When the upper bench of coal is taken down and is abreast of the lower bench of coal, the roof is thoroughly propped and the mining

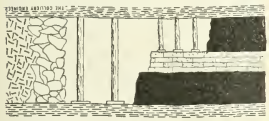


Fig. 6

of the lower bench is once more resumed.

DISCUSSION

By Mr. J. M. Gordon: "Mr. Sharp makes the statement that 'a seam of coal 1 foot thick contains 1,505 tons of coal per acre. Although the British Royal Commission on Coal Supplies takes 1,500 tons per foot per acre for estimating, the tonnage of coal in any field in Great Britain, this surely does not justify Mr. Sharp's contention, since in Canada coals range from poor lignites to hard anthracites. That is a range in specific gravity of from 1.15 to 1.50 or, in other words, a range of from 1,397 tons per foot per acre up to 1,823 tons per foot per acre.

"Another statement is made that 1 in 180 to 1 in 200 is the best gradient for a level road. He cites, as a practical example, the Fifeshire mines in Scotland where the average condition is that an empty hutch weighs 5 hundredweights, a full hutch 15 hundredweights, while a pusher weighs 112 pounds. If Mr. Sharp would go to the trouble of working the natural gradient from this he will find that it comes to approximately 1 in 107.

"Under the four headings relative to shaft pillars given in the paper, the third one should be eliminated, as it plays no part in the calculations. No shaft pillar should be left so narrow that the strength of the coal would have to play the smallest part in the determination of its size. Instead of the third might be inserted 'Allowance for any fault that the shaft may have passed through,' which is a vitally important matter; and as a fifth may be added —'adequate pillar to be left for a protection to bankhead and machinery.'

"This is a consideration in the new deep shafts now being sunk in Europe, since at these collieries the surface slant covers a large area. In the Scottish coal field, where the strata are soft, the general law for subsidence recognized in the courts of law is that one-third the depth in radius shall be left as a pillar when there are no faults to accentuate any draw in the strata. In Westphalia, where the strata are much stronger than in the Scottish fields, a pillar, the limits of which are bounded by a 15-degree angle from the points to be protected, is taken.

"When detailing the advantages of working longwall, the author states: 'The mine is generally more moist in longwall, and consequently the liability of a dust explosion is reduced.' The natural conclusion from

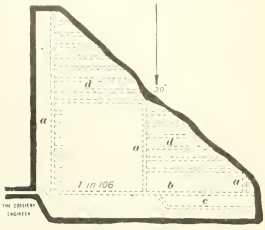


Fig. 7

a, Heading; b, Main Level; c, Dipping Level; d, Goaf Roads

this is that if the longwall method of working coal is adopted, the chances of dust explosions are at a minimum. If that be so, why in the Rhine provinces of Germany do they spray their main haulage roads in the longwall workings?

"It would also be interesting if Mr. Sharp would explain what he means by, when referring to longwall work: 'The coal is not deteriorated in quality as in pillar work.'

"In Fig. 3, the author illustrates a method of working longwall that is hardly, if ever, practised, since much more economical methods have been discovered. The first sketch, Fig. 7, shows the usual method of breaking away a longwall section from the shaft pillar along with 9 months extraction. The headings a are driven to the rise every 80 yards, and goaf roads d broken away from the headings every 10 yards. The goaf roads are cut off on the advancement of the inner headings. These headings wherever possible have the cut-chain system applied to them. c represents what is usually called the dip level. This level is seldom back brushed, since, when it begins to get too low, a new dipping is set away from the face of the level, and cuts off the operation dipping level. This dipping level is driven solely for the purpose of extracting the coal for

approximately 25 yards to the dip of the main level, so that when subsidence and creep take place, the main level will not suffer the main breaks. Mr. Sharp's Fig. 4 shows no dipping level; if a break occurred along the rib side of the coal, his level would suffer, and probably close; at any rate it would be a constant item of expense. Today in Fifeshire, nearly all the coal seams from 18 inches to 48 inches are worked by longwall coal cutters, which cut from 100 to 120 yards in a shift, the depth of the undercut varying with the height and nature of the coal. The second sketch, Fig. 8, illustrates the working of a 20-inch seam in this fashion."

By Mr. Sharp: "Mr. J. M. Gordon's remarks are doubtless based on study and experience, and from his standpoint are correct. Conditions so change in mining that what would seem best in the light of one person's experience, would not in that of another's. This is why mining is not an exact science.

"In replying, I would state that a gradient of about 1 in 180 to 1 in 200 is best suited for level roads, where the roads are well built, and cars and track offer a minimum amount of friction. A grade of 1 in 132 is probably the most suitable for sidings at shaft bottoms, etc.

"The principles, mentioned under the four headings of shaft pillars, will cover the ordinary requirements of coal mining. In the case of very deep shafts, and surface plants covering a large area, it is for the engineer to enlarge the pillars to suit the exigencies of unusual conditions.

"I have found longwall workings generally more moist than the underground workings of pillar and stall, because of the regular breaking of the strata between the coal seam and the surface, thus allowing the water to come down into the workings. Some longwall workings, however, are dry, there being little or no water in the strata and surface; but the former conditions are more general, and for that reason the likelihood of a dust explosion in a longwall working is less than in pillar-and-room working. In fact this is an important feature of the longwall method of mining that has not received sufficient attention from mining men. I have no experience of mining in the German Rhine provinces, but when the German engineers spray their main haulage roads in longwall working they doubtless have good reason, for

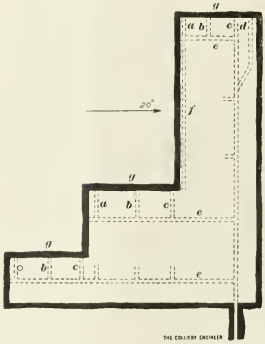


Fig. 8. Longwall in 20-Inch Seam; Using Coal Cutters and Face Conveyers

a, Air Return and Traveling Roads; *b*, Timber or Service Roads; *c*, Main Level; *d*, Dipping Level; *e*, Headings 80 yards apart; *f*, Air-Course; *g*, Conveyer Faces, 100 to 120 yards long.

as I understand it, the coal there is much softer than the general run of British and American coals, and consequently makes much more dust; besides the stratum above the coal there may contain less water than do British and Pacific Coast coal measures. My experience has been gained in these fields, and of them only I write.

"I believe I am correct in saying, 'the coal does not deteriorate in quality as in pillar work.' In the case of longwall workings, fresh or new coal is opened out almost daily, while in the case of pillar work much of it may be exposed to the deteriorating effects of atmospheric influences for years.

"The method of working described in Fig. 3, was a great success where it was employed. As to sketch Fig. 4 the level roads once enlarged give no further trouble. No dip workings were necessary. The boundary of the property was almost parallel to the line of strike. If the level road there had been driven to a grade of 1 in 107, much coal would have been left to the low side of the level and never recovered."

By Mr. Gordon: "I cannot agree with Mr. Sharp in driving his levels at a gradient of 1 in 180 to 1 in 200. Notwithstanding the proof and ressons put forward why the levels of the district under discussion should be driven at 1 in 107, Mr. Sharp still adheres to the general statements, which have no mathematical foundation. In the mines in Fifeshire where proper engineering methods are adopted, the level 1 in 200 is not a natural gradient and can never be.

"Mr. Sharp is laboring under a misapprehension when he believes the coal of Westphalia is softer and more liable to create dust than the high-grade bituminous coals of South Wales or those of the Pocahontas district of West Virginia.

"Mr. Sharp evidently believes that coal seriously deteriorates when worked by pillar and room. No coal should stand for years; that certainly is bad engineering, but the deterioration in a pillar 40 yards by 30 yards that has stood for years is only 6.5 tons out of the 1,440 tons, when the coal is 48 inches thick. This 6.5 tons has deteriorated so little that it has no effect on the commercial value of the coal; in fact this make-believe deterioration is too often exaggerated. It is only after coal has been subjected to atmospheric weathering or the action of the humic acid that it deteriorates, and then the deterioration is not as much as is usually thought. A completely weathered coal containing 1 per cent. of sulphur as ferrous sulphate ($FeSO_4 7H_2O$) absorbs 21½ calories of heat, or on an average .75 of 1 per cent. of the heating value.

"The fact that in Fig. 4, the level was driven at 1 in 180 and parallel with the march line does not make the case any better. This was only a coincidence. I have seen two or three cases where the march line was supposed to be on the strike, but actually was found to be about 1 in 20. Reasoning in the same manner as Mr. Sharp, his level would have traveled a very short distance ere it crossed the boundary."

Nature of Permissible Explosives

Different Classes of Explosives and the Conditions to Which They Are Adapted Safety Precautions—Fuse and Detonators

*By Clarence Hall**

FROM September 2, 1908, all explosives that have been submitted for official tests and have passed all test requirements of the Bureau of Mines are considered permissible for use in coal mines under certain provisions.

During the year 1913 probably 15,000,000 pounds of permissible explosives were used in the United States.

The results of researches made on explosives which failed to pass tests have been reported to the manufacturers and in nearly all cases the manufacturers so changed and perfected their explosives that later when new explosives were submitted they successfully passed all requirements of the Bureau. The tests indicate that every explosive, if fired in large quantities, will cause ignition of gas and coal-dust mixtures. An arbitrary charge, namely, 1½ pounds, has been established as the amount of explosive to be used in making tests, and all explosives in order to be placed on the permissible list must pass the gas and dust test with this amount. A charge of 1½ pounds per drill hole should never be exceeded and in good mining practice it need not exceed 1 pound and, accordingly, a greater factor of safety obtains. Explosives of many different compositions are now on the permissible list, but all have been formulated with a view to producing on detonation a relatively low flame temperature of short duration. It has been found that in order to ignite inflammable gas and coal-dust mixtures a certain temperature, acting through a certain length of time, is required. It has also been determined that the temperature on detonation of all explosives exceeds the ignition temperature of inflammable gas and dust mixtures, but fortunately the flame of the permissible explosives is of such short duration, when properly detonated, that the requisite time necessary for igniting the inflammable mixtures does not obtain. It is evident that any factor that increases the duration of the flame temperature of a permissible explosive, such as the use of a weak detonator, will increase the danger in their use.

The energy developed by the detonation of permissible explosives depends on the change of the small solid particles and liquids of the explosive into large volumes of gases, and the rate of detonation or the rapidity with which these gases are formed. To meet varying coal mining conditions the manufacturers have formulated explosives varying in speed of detonation from 4,746 to 14,560 feet per second. It is evident that for certain work where a shattering effect is desired in producing coal for coking purposes the explosive reaction should be rapid, and permissible explosives should be selected from the list having a high speed of detonation. In a similar manner a suitable permissible explosive for use in soft friable coal, and especially when lump or steam coal is desired, should be selected which develops its gases at a slow rate, in order that the pressure developed will be more prolonged. To establish their various claims of efficiency, agents of permissible explosives must conduct a series of experiments over a considerable period of time in the mines. This procedure should be encouraged for the reason that the manufacturers are constantly improving their explosives and in many cases permissible explosives which are more suitable to the work have been selected as a result of such tests. However, much of the unnecessary work could be eliminated by careful physical examination of each explosive before making tests. In several instances in mining bituminous coal it has been found that permissible explosives containing 20 per cent. of nitroglycerine have given better results and produced better coal than those made under a similar formula containing 25 per cent. nitroglycerine. The physical tests of explosives, such as in the gallery, rate of detonation, strengths of explosives as determined by lead blocks, gauges, ballistic pendulum, height and duration of flame, will be found in Bulletin No. 15 of the Bureau of Mines.

Suppose, for instance, an operator has tried several permissible explosives in a mine where the coal is soft, and has selected one as the most suitable for the work in question. From this bulletin he will note that the rate of detonation of this explosive is 2,000 meters per second. Now suppose the operator receives a request to try out a new explosive and learns that its speed of detonation is 4,000 meters per second, it would be obvious that this explosive would be too active for this particular coal. It is true a powder man skilled in the use of quick explosives might in a limited series of tests, through special skill, demonstrate the new explosive to be more economical and at the same time equally as efficient as a slower permissible explosive, but the average miner would not obtain the same results.

By carefully locating the drill holes and by loading and tamping to reduce the pressure developed, a permissible explosive of a high speed of detonation could be successfully used in nearly all coal mines. It is well known that the pressure developed by the detonation of explosives in a closed space is directly proportional to the charging density; that is to say, a 1¾-inch drill hole loaded with 1¼-inch cartridges will produce about one-half as much pressure per square inch on the walls of the drill holes as it would if loaded with cartridges of 1¾-inch diameter, and, accordingly, explosives of a rapid speed of detonation if used in this manner would be productive of a better quality of coal. This procedure of air spacing to reduce the shattering effect is

*Explosives Engineer, Pittsburg, Pa. Abstract of paper read before the West Virginia Mining Institute.

recommended by the Bureau of Mines.*

There are other means of reducing the shattering effect of explosives, such as the use of a weak detonator, reducing the amount of stemming used in a drill hole, using explosives that are frozen or partly frozen, using cartridges of explosives of less diameter than were originally tested, introducing foreign substances between cartridges of explosives, and other equally dangerous methods which not only eliminate the safety qualities of the explosives but enhance the chance of a resultant dust or gas explosion.

The American manufacturers deserve credit for their efforts in producing suitable permissible explosives to meet the economic conditions in the coal mines of this country. Many of the permitted explosives used in European countries would not be suitable for use in the bituminous coal mines of this country for the reason that they are much stronger and quicker in action. For this reason the American manufacturers have found it necessary to reduce the strength and quickness of explosives for coal mining purposes by adding inert materials or restraining substances. With explosives of this kind the average miner after a short time obtains successful and satisfactory results.

The ideal permissible explosive for use in shooting hard coal would be one that has a comparatively high rate of detonation containing all combustible materials and which on detonation produces the maximum volume of gases. Explosives of this kind could, no doubt, be used satisfactorily under all coal mining conditions, but they would have to be used in small quantities, in an intelligent manner, in coal previously undercut so that the explosive would simply exert a wedging effect on the coal.

This procedure is followed in European countries and in some cases no explosives are used in friable coal or in the longwall system of mining. Considering the comparatively high wages paid miners in this country, cheaper coal can be produced with explosives than by pick work exclusively, but the excessive use of explosives as practiced in many mines today is unnecessary and a menace to safety.

The following are different kinds of explosives classified in Miners' Circular 2:

Class 1. Ammonium nitrate explosives. All explosives belong to this class in which the base is ammonium nitrate. This class may be subdivided into two classes.

(*a*) Containing a sensitizer which is itself an explosive.

(*b*) Containing a sensitizer which is not in itself an explosive.

The ammonium nitrate explosives of subclass (*a*) consist principally of ammonium nitrate with small percentages of nitroglycerine, nitrocellulose, or nitro-substitution compounds which are used as sensitizers. The explosives, Ætna coal powder AA, Bental coal powder No. 2, Bituminite Nos. 5 and 7, Coalite 3X, Coal Special No. 4, Collier powders Nos. 3, 5, 5 Special, 5 L. F., and X, and Monobel Nos. 1, 2, and 3 are explosives of this class and contain nitroglycerine as a sensitizer. They are similar in composition to or a slightly modified form of the English permitted explosives Abbcite and Monobel.

The explosives Hecla No. 2, Titanite 3P, 7P, and 8P are explosives of the ammonium nitrate class under subclass (*a*) and contain nitro-substitution compounds as a sensitizer. These explosives, as well as those under subclass (*b*) have the advantage of not freezing when exposed to low temperatures for the reason that nitroglycerine is not used as an ingredient. They are a modified form of the English permitted explosives Withnell and Faversham.

The ammonium nitrate explosives of subclass (*b*); namely, Kanite A and Masurite M. L. F., consist principally of ammonium nitrate with small percentages of metallic oxides or other non-explosive compounds used as sensitizers. They are a slightly modified form of the English permitted explosive Westfalite. They are detonated with difficulty, requiring an extra strong detonator, and for this reason and the fact that they burn with great difficulty, are among the safest explosives to handle and transport.

All of the ammonium nitrate explosives are quite deliquescent, absorbing moisture from the atmosphere readily, therefore are not suitable for use in wet mines. If a package of ammonium nitrate explosive is opened in wet mines and the cartridges exposed for only a few hours to the damp atmosphere, it will deteriorate, and many of the failures to completely detonate are attributed to this cause. The ammonium nitrate explosives when stored under favorable conditions for only a few months show signs of deterioration; and nearly all explosives of this class after 6 months' storage at the Pittsburg testing station have failed to detonate or detonated incompletely when retested. For this reason the ammonium nitrate explosives should be obtained in as fresh condition as possible and should be used as soon as possible after their receipt. The ammonium nitrate explosives, when in a fresh condition, produce on detonation only very small quantities of poisonous and inflammable gases and are recommended for mines that are not unusually wet and also for mines and working places that are not well ventilated.

Class 2. Hydrated explosives. All explosives belong to this class in which salts containing water of crystallization modify the results of the explosion. They are somewhat similar in composition to the ordinary low-grade dynamites, except that one or more salts containing water of crystallization are added to reduce the flame temperature. They are not in general use, and tests at the station and in the field indicate that four hydrated explosives at least are not as efficient as some kinds of explosives. They have the advantage of being easily detonated, producing only small quantities of poisonous gases, and can be used successfully in wet holes.

*A better arrangement is to use less explosive of the proper diameter to fill the drill hole or the tamping will blow out. [Edit r]

Class 3. Organic nitrate explosives. All explosives belong to this class in which the base is an organic nitrate other than nitroglycerine. The permissible explosives of this class are listed in Miners' Circular 2 as nitro-starch explosives. They do not contain nitroglycerine and for this reason do not freeze. They contain large quantities of inert matter and, therefore, are not as effective as they might be if they were made containing smaller quantities of this material.

Class 4. Nitroglycerine explosives. All explosives belong to this class in which the base is nitroglycerine. The flame temperatures of this class are reduced by the addition of free water or by using an excess of carbon for the purpose of reducing the amount of carbon dioxide formed. A few contain salts which reduce the strength and shattering effect of the explosives on detonation. They are somewhat similar to or a modified form of the English permitted explosives Britonite, Carbonite, and Kolax. The nitroglycerine class of explosives have the advantage of ease of detonation and not being readily affected by moisture. Less skill is required in their use and the average miner obtains satisfactory results in a much shorter time than with the other explosives. They have the disadvantage of freezing at comparatively high temperatures; and even when nitro-substitution compounds or other materials are added to lower the freezing point, they will not remain unfrozen below 35° F. They produce a large percentage of poisonous and inflammable gases on detonation, many of them producing quantities equal to that of black blasting powder, and for this reason should not be used in mines that do not have efficient ventilation.

Permissible explosives are discharged by means of detonators in which the weight of the fulminate varies according to the explosive used. Detonators are usually attached to fuse for firing charges of explosives. When detonators are fitted with a means of firing them with an electric current, the device is called an electric detonator. As electric detonators are embedded in the explosives and isolated by means of stemming, they are the safest means of igniting charges of explosives in gaseous mines. The variation in the moisture conditions of material to be blasted requires several kinds of fuse in order to adapt them to the various conditions. The five classes of fuse are as follows:

1. Fuse for use in dry material.
2. Fuse for use in damp material.
3. Fuse for use in wet material.
4. Fuse for use in very wet material.
5. Fuse for use in submarine work.

The first two fuses are generally used in the coal mines of this country. They are the cheapest grades, and on account of the lateral sparking which occurs on burning are not recommended for use with permissible explosives. If the detonator is buried in the explosive, the lateral sparking which occurs with this kind of fuse may set fire to the explosive before the detonator is set off.

Fuses 3, 4, and 5 are well made and show little, if any, lateral sparking or glowing at the sides. However, even these fuses are not safe in gaseous mines. Tests made with fuse generally offered for sale in this country have shown that the end spitting of the fuse will cause ignition of inflammable gas mixtures.

A new kind of fuse has been tested and appears to be much safer than the fuse generally used in coal mines. This fuse is of a good mechanical construction having a sufficient resistance to the pressure produced within it by the burning powder train to prevent its bursting through the envelope. The quantity of powder per foot is less than in the ordinary fuse and in the preliminary tests no ignitions of inflammable gas mixtures occurred from the spit of this fuse. However, as fuse does not *per se* contain its own means of ignition, it cannot be considered apart from the fuse igniter, a means employed to cause the ignition of the fuse. Clearly, any fuse igniter that would ignite gas when properly attached to a fuse would be condemned as well as any fuse igniter which did not surely ignite fuse with which it is used. It should not be concluded, however, that any fuse having the proper envelope and even when a safe and reliable method is provided for its ignition can be safely used in a body of inflammable gas. The various kinds of fuse differ in speed of burning, varying from 18 seconds per foot to 40 seconds per foot when tested in the open air. The miner or shot firer seldom has information on the speed of burning of the different kinds of fuse. It is true, that some fuses are marked slow or fast burning and some kinds are distinguished by different colors of paper wrapper, but this is not always the case. Without such information a miner may become accustomed to a certain fuse and on using another brand that burns faster the charge may explode prematurely. This is a menace to all connected with the work. It is generally conceded that the use of fuse of different speeds of burning is not desirable, that if all classes were made to burn about 90 seconds per yard in the open air and this speed maintained within 10 per cent. over or under the stated time, such requirements would meet all ordinary mining conditions and offer greater assurance of safety. The manufacturers of fuse realize that the many kinds now manufactured having different burning speeds are unnecessary, and would, no doubt, welcome a standard speed of burning of fuse. It is believed that the required speed of burning of fuse, namely, 90 seconds per yard, recently adopted by the Isthmian Canal Commission and the United States Reclamation Service, would meet the various mining conditions in this country.

The tests which have been made on the spit from squibs invariably ignite inflammable gas mixtures. As squibs must be propelled from the mouth of the drill hole to its heel by a propelling power of the spit of the squib proper, it seems quite impracticable to adequately protect this spit from inflammable gas mixtures within mines, hence the use of squibs of any kind cannot be commended for use in mines generating inflammable gases.

The system of firing shots in connection with electric detonators from the surface when all men are out of the mine, previously adopted in Utah, has been introduced in Colorado, Alabama, and other states. This method has many advantages and its adoption in mines where the local conditions permit would, no doubt, reduce accidents in coal mines.

The dangerous practice of using inflammable material for stemming is generally being remedied by the employment of clay and like substances in all parts of the country. The humidifying of mine air by means of steam and water sprayers has progressed rapidly, and the enforcement of the laws by the state mine inspectors concerning coal mining operations has greatly improved in recent years. The mining conditions of this country as regards preventatives of explosions are approaching a position of equality with European countries and it is expected that there will be a steady reduction of accidents from this source in the coal mines of this country in the future.

Fig. 1. Tipple at Mine 21, Consolidation Coal Co.

Fire at Consolidation's No. 21 Tipple

The Consolidation Coal Co. was unfortunate in having a fire originate at the No. 21 plant about 6 A. M., January 19. The fire destroyed all that part of the tipple from bent No. 1 to bent No. 6, inclusive, and also the covering above bents No. 7 and No. 8, over the loading tracks, together with all the chutes, screens, and machinery for loading the coal, with the exception of the slack bin and that part of the conveyer machinery on top of the slack bin, this bin being at the end of the tipple just beyond the No. 1 bent.

The loss amounts to about $30,000 on which there is the usual insurance.

The plant is equipped with fire lines and four streams of water were on the fire very shortly after it originated. In addition, one of the company's 500-gallon chemical engines arrived on the scene early in the morning, and due to the fire fighting

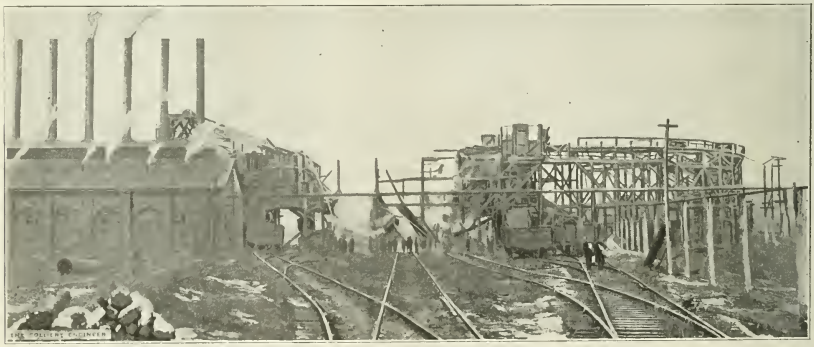


Fig. 2. Tipple at Mine 21, Consolidation Coal Co., After the Fire

equipment, the fire was held within the limits mentioned and was entirely out at 11 A. M.

The No. 21 plant of the Consolidation Coal Co. is about half-way between Fairmont and Clarksburg, on the Monongahela River Division of the B. & O. R. R. The tipple and approach is about 600 feet long. It is equipped with chutes and screens and other necessary machinery for loading run-of-mine, slack, pea, nut, egg, and lump coal, and has a slack bin with the conveyers and necessary apparatus for loading the electric larries for the coke ovens. There are seven loading tracks under the tipple, with the capacity for 131 empty and 96 loaded cars, in addition to the railroad yard located at this point, which has a large capacity. About 1,000 gross tons per day are loaded at this plant, which is one of the older installations of the company, but has been kept up to date and in efficient condition.

The wreckage of the fire was entirely cleared away by January 26 and equipment replaced, so that on that date coal was loaded for the coke ovens, and by February 1 sufficient temporary equipment was erected to load coal for consumers. During the time of making repairs, there was no delay in shipments to consumers, their wants being supplied by other of the 48 mines belonging to the company in the region.

The attached photographs show this plant previous to, and after the fire. This and past performances of the operating department of the Consolidation Coal Co. show to what extent efficiency prevails. In 1906, when the No. 24 tipple was destroyed, the first temporary dump was completed within 4 days and the complete temporary tipple was in operation within 3 weeks.

Conservation Begins at Home

The paper used by the government printing office each year requires approximately 125 million pounds of rag pulp and 490 million pounds of wood pulp.

34-8—5

Moving Pictures

For Accident Prevention—Pictures and Lectures Employed by the United States Coal and Coke Co., at Gary, W. Va.

Written for The Colliery Engineer

BELIEVING that sight makes a more lasting and vivid impression on the mind than words, the United States Coal and Coke Co., of Gary, W. Va., makes use of moving pictures to show the dangers encountered in mining, and how to avoid them. In displaying these pictures, the lecturer states what the company is doing to protect its men from injury, and suggests what the men should do to protect themselves, for the reason that the company cannot do the work the men do, therefore, without the aid of its employes, injuries and deaths cannot be prevented.

The first reel shows an assistant foreman examining the places in that section of the mine which is under his jurisdiction. This man, who in Illinois, is called the face boss, has about 15 places to watch and see that the work is properly carried out so that no one will be injured. He is the first to enter his section in the morning, and no one can pass the gate he places across the traveling road until he has examined the working places for gas and bad roof. In each room there is a report board on which he marks the time of his visit to the place, and he makes several daily. This report of his visit protects him from being considered derelict in his duties, should an accident occur between his visits. After making his round of examinations, he returns to the gate where the men by this time have assembled, and marks on the bulletin board those places that are in good order; and if any places are dangerous he tells the men what they are to do to put them in order, after which he permits them to go to work, stating that he will visit them shortly. If there is a very dangerous place, men are not allowed to go to it until he goes with them and directs the work personally. These mines are worked by machines, therefore the miners' work consists in standing props to prevent falls of roof, laying room track, drilling three holes in a working place, charging them with powder, tamping the powder, and loading into cars the coal that is broken from the face by the blast. The miners work in pairs, and the first thing they do when they reach the face of their working place is to sound the roof, and examine the coal; then, if everything is secure, they proceed to lay a short section of track, but if not secure, the place is to be made so.

The track is laid on Carnegie steel ties, which are light and readily handled and require no spikes, the fastening and unfastening to the rail being done by means of a hammer and a swiveled clip that rides one flange.

The next duty a miner performs is to watch for a car and see that it is placed and chocked properly, so as not to move during the time loading is going on. The machine runners make the undercut at night and leave the small coal cut by the machine on the floor; the miner is required to load his coal into a car before he does any blasting; the object being to prevent any possibility of a dust explosion from a blown-out shot.

After this is done, one miner drills the center hole, while the other prepares the explosive and tamping. At this company's mines permissible explosives are used, which require the use of strong and sensitive detonators, therefore, one man is required to carry the explosive in a bag, while the other miner carries the detonators in a block of wood placed in a special case. On reaching the working place the explo-

sive is placed in a hole cut purposely in the rib and not nearer than 100 feet from the face; while not less than 30 feet away from the explosive, the detonator or caps are placed in another hole. Clay is brought from outside the mine and placed in the working places in bulk, where the miner can make it into rolls.

To prevent the miners using coal dirt as tamping, the assistant foreman breaks one roll of tamping to see that it is clay. The shot hole having been scraped free from fine coal dirt, three cartridges have the paper torn from the ends so that the explosive of one will be in direct contact with the explosive in adjacent cartridges, and by this means assuring the detonation of all the explosive. The highest charge permitted in these mines is 2 pounds of powder, but as a usual thing only 1½ pounds is needed. While the hole is being charged and tamped by a wooden bar by one miner, the other miner drills a hole near the right-hand rib. When the hole is ready to be fired, the miners remove their tools from near the face, while the assistant foreman, who fires the shot, attaches the wires of the detonator to the leading wires, after which all retire out of the line of the shot and the detonation is accomplished by an electric blasting machine. Before the miners are permitted to enter the room, the assistant mine foreman examines the place, and if he finds loose rock he remains with the men until it is taken down or posts set to secure it.

The miners next load the coal into cars, which are placed in the rooms by a Jeffrey electric gathering locomotive. As the miners load the coal, they pick out the slate and throw it in the center of the room, and also cut off the coal from bone and throw the latter in the gob. The car is pushed so close to the face that both miners can load from the side, and after it is filled, the motor removes it from the room and replaces it with another car. After the coal has been cleaned away sufficiently the miners are required to place a post with cap, regardless of the condition of the roof, at a point within 6 feet of the new face and 6 feet from the last prop.

While the miner drills the third hole, the other miner charges the second hole and the assistant foreman follows the same procedure as before in firing, etc., only one shot being fired at a time.

After loading out the coal the miners timber the room to within 6 feet of the face, using a sliding measuring stick to find the length of the post. After allowing for the thickness of the cap piece, he cuts the post to exact length and by this means avoids the use of wedges between the posts and the cap piece. The posts are set 3 feet apart along the roadway and 7½ feet from the rib; these posts are kept in alinement by means of a sight line 2 feet inside and directly over the outer rail. Six-foot cap pieces are turned at right angles to the roadway to afford some protection over the road, but in case the roof is bad, a bar with one end resting on the post and the other on a hitch cut in the coal is used. A space is left between the bar and the roof, so that lagging can be put in place. Two back rows of posts are set on 6-foot centers with cap pieces about 4 feet long and parallel to the roadway. This systematic timbering is carried on, whether the roof is strong or weak, to avoid taking chances on roof falls, and requires three rows of posts which cover 18 feet of the 20-foot wide room. Before the miners leave their rooms for the day they are required to square up the places and remove a short piece of track, so that everything will be in readiness for the machine men.

After the miners leave, the assistant mine foreman enters the room and extends the line sights and marks the proper width of the room, so it will be driven straight and of the proper width. He marks the sight line of the working place with an arrow and also marks a white line on the roof indicating the sight line of the room. He next examines the place to see that it is safe for the machine men, and if it is, he puts his "O. K." on the face. Before he leaves, he sees the machine runners and gives them a list of places that are O. K.; and no machine runner is permitted to take his machine into a place that is not O. K'd. by the assistant foreman.

The Sullivan mining machine is shown entering a room, by its own power. The machine men, after examining the roof, timbering, and coal face, remove their tools from the truck, and then the machine is made to unload itself. The men are shown standing in positions where they will not be injured while the machine is unloading. After unloading, the machine is shown moving toward the face to make the sump cut, and then the runner and helper are shown lining the machine with the sight line to make a straight cut. The machine makes a sump cut of 8 feet 6 inches and when the cut is extended across the room 20 feet, there is enough coal cut to furnish each miner with from 15 to 20 tons to load for a day's work. The helper is shown setting the jack-pipe to hold the chain upon which the machine propels itself across the face, cutting the coal at the rate of 25 inches per minute, in fact, it cuts so fast that one man is kept shoveling the cuttings out of the way of the machine. After the place is cut, the machine is shown traveling back toward the truck at a speed three or four times as fast as it moves when cutting, and then it is shown loading itself on the self-propelling truck which moves it to the next room. In all their movements the machine men are taught to be on the safe side when doing their work, with the result that there are few accidents from mining machines.

Also, one of the O'Toole cutting and loading machines which cuts out the entire seam and loads it into mine cars is shown. This machine is designed for mining coal that is to be used for making coke.

The mine cars in use at this mine

are of steel and fitted with Carnegie rolled-steel wheels constructed in the same manner as railroad car wheels. The room tracks are placed so that there is a clearance between the sides of the car and the posts and ribs of 18 inches. The mules which gather and distribute cars are able to pass between the posts set along the track on 3-foot centers and the machine men have no difficulty in readily moving their machines between the coal and posts placed 6 feet from the face. One of the company rules is that no one shall ride on the front of a car whether loaded or empty, consequently the drivers ride the tail-end. the empty train as he starts to the mine.

When the trip goes into the mine the brakeman is required to ride sitting down in the last empty car. The company has a merit and demerit system for its foremen, awarding premiums for the prevention of accidents. The demerit board shows the daily standing of each foreman.

Welfare Work

Of the Kingston Coal Co.—A Description of the Many Ways by Which the Safety and Comfort of Mine Workers Are Assured

Written for The Colliery Engineer

At the No. 4 mine of the Kingston Coal Co., at Edwardsville, in the Wyoming anthracite fields of Pennsylvania, three different railroads connect with the breaker. The company's spur tracks connect with these railroads, and where they cross the streets in Edwardsville the company, in addition to flagmen and rail crossing signs, has installed gongs which can be heard a block away each side of the track. At one place where it was convenient for school children and people to cross the company's ground and tracks below the breaker and so save a walk of four blocks, Mr. F. E. Zerbey, the manager, constructed a steel foot-bridge, shown in Fig. 1, and fenced in the tracks, thus forcing pedestrians to make use of the bridge to cross over the tracks. As this was the company's ground, it shows the spirit of accommodation, desire to help and at the same time avoid accidents, which exists in the anthracite fields. Wherever there is any likelihood of an accident inside or outside the Kingston Coal Co.'s mines, there will be found a danger sign calling attention to the matter; and as all machinery, shafts, and dangerous places are fenced, accidents can only happen by persons going where they are forbidden to go. In case a person is injured in the mine the nearest first-aid corps is summoned, then the office is informed, and next the surgeon. It is possible to summon the surgeon from inside the mine by means of the telephone exchange which connects the telephones inside the mines with his office; in fact, arrangements are such that a person in another city can be talked with from far inside the mine, and from any of the numerous levels.

Fig. 1. Foot Bridge Over Tracks

Fig. 2. Bath House and Locker Rooms, Kingston Coal Co.

In the last part of the fourth reel miners are shown coming out of the mine after their day's work is over. They hang their checks on the board to show that they are out of the mine, after which they take their tools to the blacksmith shop and then start for home. If a check is missing at night the checkman reports it to the mine foreman who must immediately find out whether the man left the mine, and if not, why he is still inside.

A loaded trip is also shown coming from the mine attached to a 13-ton Jeffrey electric locomotive, which hauls 100 tons of coal per trip on the ordinary grades. The motor is equipped with an arc light, and a torch is hung on the rear end of the motor. No one except the motorman or brakeman is allowed to ride the trip. The motor is ahead of the trip as it is considered dangerous to push it. This arrangement requires a separate runaround at each side track, so that the motorman can place the motor at the front end of

There are a number of inside hospitals in the company's different mines, but at these places the injured are treated only for actual needs by the first-aid corps, and then, if necessary, they are removed to the operating room at the surface where the regular surgeons perform the operations, prior to the patient's removal to the Wilkes-Barre hospital.

It has been the custom to build wash houses for the underground workers where they can take baths and change from dirty, and sometimes wet, working clothes to dry street clothes. The Kingston Coal Co. has arranged bath houses at its collieries so that the men may wash their heads and faces in vitrified wash

bowls supplied with cold and hot water, and afterwards their bodies with a shower bath. These shower baths are arranged with movable sprinklers whose sprays can be directed toward any part of the body. The water spigot is a new arrangement that makes it impossible for a person to become scalded, as it has graduated notches and one lever which starts with cold water and gradually turns on the hot until both

graph shown in Fig. 4 was taken the colliery was not in operation, when it is, however, there is at quitting time a rush for the bath tubs in preference to the shower baths. Each man supplies his own soap and towel and is obliged to wash out the tub he has used. There is a company man in attendance who airs the miners' working clothes; sees that they are dried and does the other necessary work incidental to keeping

as safe as it is possible to make them, a lamp man is hired. When the miners are ready to go into the mine they go to the lamp house and are given safety lamps in proper condition; these they examine, and before they go down the lamps are examined by a third person, who locks them with a key or a magnetic lock. Because of the dangers from gas, the miners are not permitted to have lamp keys or matches, or to take pipes

Fig. 3. Locker Room, Kingston Coal Co.

Fig. 4. Bath Room, Kingston Coal Co.

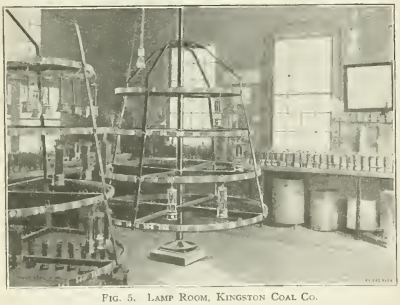


Fig. 5. Lamp Room, Kingston Coal Co.

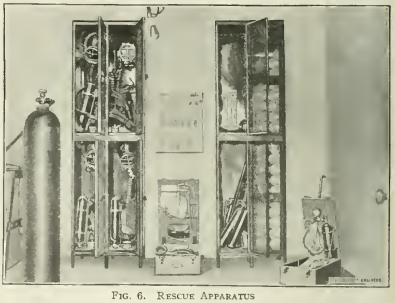


Fig. 6. Rescue Apparatus

mingle and form the temperature desired. At the No. 4 bath house, shown in Fig. 2, there are three rooms: One contains 288 steel lockers, as shown in Fig. 3, the center room contains 36 cement bath tubs, the wash bowls and the shower baths; as shown in Fig. 4, the third room contains 144 steel lockers and has room for 144 more. Similar bath houses are at two other mines of the company. On the day the photo-

the bath house ventilated, clean, and heated. No charge is made for the use of this house or the lockers, but the men are obliged to buy their own locker padlocks.

The mines in the Wyoming Valley field are very gaseous, for which reason safety lamps are in general use. This compels the company to purchase safety lamps for its mine workers; and to keep the lamps in proper repair, so that they will be

underground for fear that in a fit of absent mindedness some one of them might light up and kill some of the others. In order to standardize and reduce the number of lamp parts needed for repairs, the Davy and Clanny lamps have been adopted by the Kingston company. Fig. 5 shows the lamp room with the lamps to be cleaned on the bench and those that have been cleaned hanging on the two movable lamp stands. Recently

this company purchased electric cap lamps; these, with the charging table and lamp bench are in the same room as the other lamps, but could not be shown in Fig. 5.

This company, like most of the other anthracite companies, adopted oxygen helmet apparatus some years ago, and trained men in its use in the hope that the apparatus might be instrumental in saving life and of use in case of fire inside the mines. The rescue apparatus shown in Fig. 6 is kept in a room adjacent to the surface hospital, where trained men may reach it quickly. It is used each week and kept in thorough order so that there will be no waiting to assemble parts. Two kinds of pulmotors are shown in Fig. 6, one is for an asphyxiated person who cannot work his lungs, and the other is for a partially asphyxiated person, who is able to breathe but whose lungs require stimulation. The lockers and pulmotor boxes are kept closed, but the apparatus is always in readiness for instant use.

Several years ago Gen. Mgr. Zerbey provided a club house and reading room for employes of the company. Here the men meet to talk over matters, study, and at intervals hear lecturers. This club house has proved a good investment for the Kingston Coal Co., because it has stimulated the dormant possibilities of men, and those who knew have told what they knew to others.

While the company has done much along lines of welfare work for the men, it has not overlooked the fact that the men have wives and children, two instances of which have been mentioned, namely, the crossing signals and the cross-over bridge. Mr. Zerbey after putting the houses on a modern basis of comfort, graded a piece of ground for a children's play ground. This was so well patronized he turned it into a free recreation park, which in summer is patronized to the crowding point with approximately 1,000 in attendance. Each year a new attraction is added, and this, with the sociability at the park, keeps the young people from the streets and attracts their elders. At present there is a barrel-organ and carousel run by electricity, a victrola, many swings, slides, seesaws, and other amusements. A special officer is deputized to keep order and see that all leave the grounds when the 9 P. M. whistle blows. The writer is indebted to Mr. Solomon, mechanical engineer of the company, for the information in this article.

Gas in Coal

Discussion of a Paper by N. H. Darton on Gas in Coal and the Pressures Under Which It Is Confined—Influence of Earthquakes

Written for The Colliery Engineer

A MEETING of the New York Section, American Institute of Mining Engineers, was held in New York City, in January, 1914, the Chairman, Mr. L. D. Huntoon, presiding. There were forty members present.

Mr. N. H. Darton, from the United States Geological Survey, talked on gas in coal and the pressures under which it was confined. The investigations were made in the Wyoming Valley field in the anthracite region and in the southern Illinois field, and from these and the data obtained from experiments carried on abroad, a series of charts were made, that later will appear in the Bureau of Mines literature. The mixture of gases that emanate from coal is quite complex and variable and in some cases coal underground contains gas under considerable pressure. Analyses showed that in many of the coals tested there were from one to two volumes of gas; and as some gas escaped when the sample was taken, it would indicate that a considerable volume of gas was occluded in the coal, and under pressure. To ascertain some of the pressures, holes were drilled in the solid coal in the mine, tubes inserted and tightly tamped about, and then pressure gauges attached to the tubes. After Mr. Darton's address there was a discussion as follows:

By Mr. Richards: There is one interesting point that occurs to me; in very gassy coal a hasty calculation would show that the weight of the methane was very nearly 15 per cent. of the weight of the coal mined; it would possibly represent about 15 per cent. of the caloric power of coal mined.

By Mr. Beard: I would like to ask a question—if Mr. Darton could tell us anything of the relation of seismic disturbances to the production of gas in mines.

By Mr. Darton: I have not considered that subject myself. A few of the foreign writers believe there is some such relation, and others deny it very vigorously.

By Mr. Beard: It has always been a great question in my mind as to what the condition of this gas is in the coal and in the strata. Of course, when we think of these tremendous outbursts of gas from the strata, and thousands and millions of cubic feet coming out from day to day, we must wonder where it comes from. One supposition, of course, is that it not only comes from the pores of the strata, but that it must come also from large reservoirs and crevices, that the gases are released from them through disturbances such as occur from natural causes. I refer to seismic disturbances. It has frequently been observed that an immense eruption or earthquake occurring on one side of the globe would be accompanied at the same moment, almost, or within a short time, with a tremendous outflow of gas in mines, and sometimes by an explosion in mines. At the time of Mount Pelee eruption, when Mount Pelee let out, we had three different mine explosions occurring in different sections of the globe, one in Tennessee, one in British Columbia, and one in Australia, with a loss of life of over 500 men. We cannot say that a seis-

mic disturbance on a great scale would necessarily be accompanied with mine explosions; we might naturally say that such disturbances would have the effect of releasing gas by the movement that takes place in the strata. We might agree to that—it seems reasonable to suppose that it would be so.

I have kept close tab for 7 or 8 years past on the outflow of gas in mines as connected with the movements of the barometer. While I cannot say that there is any relation between the two sufficient to assume that any great change in the barometer would be accompanied with a like outflow of gas in the strata, it seems reasonable to suppose that when the barometer falls gas would come from the strata somewhat more readily. But I think Mr. Darton referred to that (I came in a little late) and when you come to figure up the effect of the expulsion of gas, even in abandoned areas of mines, and figure up how much would be thrown out from the volume of standing area, and estimate the percentage of increase in the large volumes of air that are circulating in the mines, you find it is not enough to make any appreciable change in the percentage of gas in the air.

I have not been able to find that there is any reasonable ground to connect the two—you could not expect to find any appreciable amount of increase in the percentage of gas. But I am very much interested in the question of seismic disturbance and its effect on the mine, in the outflow of gas from the strata. I do believe that there is a strong connection there, and we cannot always expect an ignition to occur, but it seems reasonable to suppose that there would be certain danger periods. I notice that when volcanoes are very active in different portions of the globe we have less trouble in the mines, but when the volcanoes are plugged, so to speak, that is, when the eruptions are less frequent, and especially if there is an earthquake, then there is very apt to be trouble, and we are very apt to hear of mine explosions occurring.

By Mr. Darton: I think most of those mine accidents that Mr. Beard speaks of are due to dust, and not to gas. Nearly all of the great explosions are due to dust, and not the gas emanations. They are not known to be connected with gas at all, unless the initial explosions are started by a small amount of gas.

By Mr. Beard: That is true, yet at the same time I think, that nearly all explosions are attributable to the presence of gas, and of course none of us can say that these explosions are gas explosions or dust explosions. I believe there are very few purely gas explosions, though there may be some, and I believe there are very few purely dust explosions—I mean explosions started by dust alone. I believe the principal trouble comes from a certain percentage of gas, that becomes ignited and starts an explosion, and the moment that starts the dust is raised and the explosion is augmented.

By Mr. Saunders: I thought it had been well demonstrated by the Bureau of Mines, in the vicinity of Pittsburg, that the presence of gas is not always necessary to a coal-mine explosion. I fail to see why a seismic disturbance should in any way produce an explosion in a coal mine in Australia, if the seismic disturbance occurs, for instance, in America. It seems to me that the cases referred to by Mr. Beard were merely coincidences. If it is true, as demonstrated by Doctor Holmes, in the experiments conducted by him, that the agitation of dust will result in violent explosions, is it not natural to assume that a shock in the earth somewhere might scatter the dust and produce explosions? These seismic disturbances are hardly comparable to the explosions from the discharge of drill holes in mines.

By Mr. Beard: I do not want to be misunderstood in regard to what I said about the coincident happening of these explosions with the seismic disturbances. I only spoke of them as coincident. I would not for a moment attempt to say that one was caused by the other, but I simply say that it is very natural to suppose that when these tremendous disturbances occur in the earth, there should be a release of gas from the strata that would pour into the mine in volumes, perhaps. I see myself a very reasonable ground for assumption, but I do not want to be understood as saying that I believe that it is, perhaps, any more than Mr. Saunders says. I cannot say that the gases were released by the shocks. I question in what condition the gas exists; I do not believe it is simply in the strata of the coal; any one who is familiar with mines has heard the thumpings and poundings in mines, to which you can listen, so they seem like distant heavy falls of some kind, and almost must believe that this is the result of the gas working. If the reservoirs of gas exist at all, is it not reasonable to suppose that when you have a heavy disturbance in the earth it is not in one place only, for the earth is a unit in itself, and a disturbance may affect one side of the globe at the same time as another. Who will deny that there are fissures that extend through great portions of the globe, in other words, that the entire globe is more or less sensitive?

By Mr. Saunders: I am very sorry to differ so much with Mr. Beard. Regarding the thumpings to which he refers, I have been present when the thumpings have been due to causes other than gas. I have been in the bottom of the Red Jacket mine when there have been repeated explosions, so loud that you might suppose a gun had been fired in the mine, due to the going off of the footwalls. It is a common experience in railroad construction and quarrying. That is simply due to the fact that the pressure is being relieved, and has no reference whatever to gas. In the Red Jacket mine, the noise is simply due to the pressure having been relieved by the

mining operations, and is simply working itself out.

By Mr. Beard: I think it ought to be mentioned that these poundings in coal mines are considered by old miners as warnings to get out, and they often do get out and wait for 2 or 3 days, or a week or so, until the disturbances settle, simply for fear of an outflow of gas. That is frequent in the mining sections in which those poundings occur.

Pennsylvania mines the gas pressure runs up to 100 pounds per square inch, and probably greater. I think a fairly good blast in a chamber or a series of chambers amounts to a good deal more than the movement from an earthquake 20,000 miles away. If the coal mine withstands those shocks, an additional earthquake or two would not affect the mine.

By Mr. Huntoon: In the storage

Kingston Coal Company's Hospital

Written for The Colliery Engineer

The Kingston Coal Co.'s plants are in Kingston and Edwardsville, Pa., a short distance from Wilkes-Barre, and so situated that they are able to ship over the Lehigh Valley; Delaware, Lackawanna & Western; and the Delaware and Hudson railroads, and shortly will be able to ship over the Pennsylvania Railroad; it is

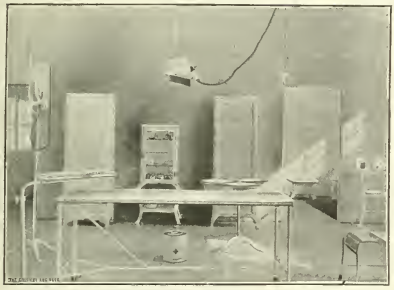


Fig. 1. Operating Room, Kingston Coal Co.

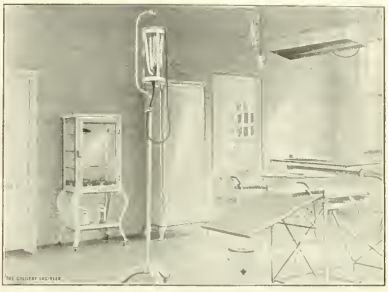


Fig. 2. Another View of Operating Room

By Mr. Richards: Where there is gas under such pressure, and when a shock occurs like that when Mount Pelee went off, I think it is quite conceivable that that sort of a shock might open up minute fissures through the coal beds, which would release the gas. Mr. Saunders' explanation just gives you a picture of what may happen when a shock comes.

By Mr. Darton: The stresses in coal mines are very great, and a small disturbance may have considerable amplitude. Gas under a pressure of 500 pounds per square inch is under an enormous stress. In a coal mine half a mile deep there is a rock pressure above of 1½ tons to the square inch; then the water column has a weight of 435 pounds per square inch in such a mine. When these forces are disturbed it is very natural that there should be considerable rearrangement. I think the idea of Mr. Saunders is a just one, that the disturbances are due to the rearrangements. In many of the of anthracite, which takes place to such large extent, is there not a great deterioration in the gas content?

By Mr. Darton: All coal oxidizes to some extent, and loses in caloric power—anthracite less than bituminous.

It was moved by Mr. Dwight, and seconded, that a vote of thanks be extended to Mr. Darton for his address, which motion was unanimously carried.

Capacity of Pipes and Cylinders

Given the dimensions of cylinder in inches to find its capacity in United States gallons. Square the diameter d, multiply by the length, l and by .0034.

$$\text{Capacity} = \frac{d^2 \times .7854 \times l}{231} = .0034 d^2 l$$

If the dimensions are in feet then, Gallons

$$= \frac{D^2 \times .7854 \times L \times 1{,}728}{231} = 5.875 D^2 L$$

therefore not dependent on one line of railroad for shipping facilities.

This company was one of the first to make use of first-aid corps in the Wyoming Valley field and to construct underground hospitals for temporarily relieving the injured. But owing to the comparatively long ambulance trip between the mines and the hospital Gen. Mgr. F. E. Zerbey was not fully satisfied. There have been cases where the injured possibly have died because of the long time which must necessarily elapse between the accident and the operation at the hospital. Again others have died from the shock produced by the accident, and the shock produced by the operation, their vitality having been depleted by the lapse of time between the two.

After consultation with the company surgeons it was decided to fit up an operating room at the No. 4 mine, where the patient could be operated on and sent to the hospital for nursing and recovery. This room is large, light and roomy, with all the

necessary hospital apparatuses required. The walls are of brick and the floor is of cement, both being covered with several coats of cement paint which is practically an enamel paint, from which dust may be removed by a cloth.

The mine workings are connected with the office by telephone and in case of an accident a surgeon will be at the operating room as soon as, and sometimes sooner than, the injured person.

Figs. 1, 2, and 3 show the arrangement of the operating room, all of the furniture being of steel enamel, and of approved hospital design. The room is lighted by large windows, the lower sashes of which contain white prism glass, and the upper clear glass; it also has electric lights.

In the center of the room is an operating table *a* on one side of which is an instrument tray *b*; on the other side a three-bowl solution stand *c*; one bowl for water, one for antiseptic solution, and the third for sterlizing solution. Above this table is an operating cluster of electric lights *d* arranged with balancing weights so it may be raised or lowered as the surgeon desires. Above and to one side, where it can be readily reached when needed, is an irrigator for washing out cuts, etc. The pressure from the irrigator is increased by raising it toward the roof. In another part of the room there is a collapsible operating table *f* with the necessary appurtenances. At *g* there is a steel supply cabinet with bandages, splints, and tourniquets; at *h* a cabinet where the surgeon's instruments are kept, at *i* is a clothes press for the surgeon's operating clothes. The cabinets are dust proof with glass doors wherever needed. In the corner at *j* is a sterilizer for instruments and for water, and at *k* is an instrument table with shelves and top made of glass.

In addition to the necessary furniture for operating, there are three steel enameled chairs *l*. This room which is steam heated and lighted, connects with a toilet room in which there is a clinic lavatory *m*, with hot and cold water. The water is turned on by foot levers and the wash bowl emptied in the same way. At *n* there is a foot-bath and at *o* a sink, all being steel enameled.

In another room which is entered by a door from the operating room or from outside is kept the oxygen apparatus in closets *p* and *q*, pulmotors, oxygen tanks *s* and pumps *r*. In cases where it is necessary to

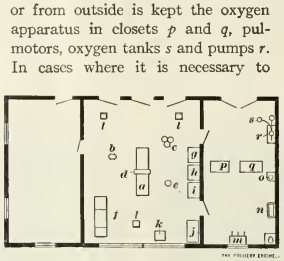


Fig. 3. Plan of Office, Hospital and Apparatus Room

administer ether, Doctor Lake has for assistants two men from the first-aid corps who have been trained for the purpose.

In all accident cases two reports are made, one for the State Mine Inspector of the District, and another for the company. On the latter report there are two cuts showing the front and back of the human figure, which are used to show the place where the man received his injury. The form of report used is shown herewith.

Accident Report, The Kingston Coal Co.

*Name of Colliery*_____ *Date*_____
*Report of Accident to*_____
*Residence*_____ *Age*____ *Married or Single*____
*Nationality*____ *Naturalized?*____ *How Many Children?*____
*Occupation*_____
*Time of Accident*_____
*Nature of Injury*_____
*Where Did Accident Occur?*_____
*How Did Accident Occur?*_____
*Witnesses*_____
*Where Was First Aid Given?*_____
*By Whom?*_____
*Where Was Injured Person Taken?*_____
*How Was He Removed?*_____
*Name of Physician First Called*_____
*Place of First Examination by Physician?*_____
_____ *Foreman*
*Result*_____
*Date of Return to Work*_____

Through the kindness of Mr. Zerbey, and Mr. E. L. Solomon, the mechanical engineer, and Mr. T. H. Williams, the mine superintendent, the writer has been able to furnish something which he believes to be new in the first-aid line and which will no doubt appeal to others.

Cooperative Central Station Possibilities

*By David R. Shearer**

It is a fact almost universally recognized in engineering circles that greater economy and more satisfactory service in the production of power is possible by the use of large central stations than of those of smaller capacity. This is accounted for by the fact that better machinery may be used and greater facilities installed for the proper handling of fuel, ashes, and water supply, and also because less labor is required per unit output. Moreover better trained men may be employed and higher wages paid for more expert service and supervision of the plant operation. Practically all steam and electrical machinery increases in efficiency to some extent with the size of the unit, and also costs less per kilowatt installed than equipment of a smaller size.

With the above principles as a working basis, mine operators are coming to realize that it is often advisable to install central plants serving several different mines, intending thereby to secure a cheaper power, and more efficient and reliable service than by individual plants installed at each mine.

The plan upon which such a central station may be designed and operated is as follows: Several mines lying in contiguous territory form a stock company, each owning a certain number of shares in the corporation. This subsidiary company constructs the power house, installs the necessary equipment and erects the transmission lines and distributing network. Adequate arrangements are installed for handling coal bought from the different mines which are members of the plant corporation and for keeping accurate records of operating costs and output. Meters are installed on the services which feed the electrical equipment used for operating each mine, and a regular scale of charges is made which depend to some extent on the cost of producing electricity. A competent engineer is placed in

*Electrical Engineer, Knoxville, Tenn.

complete charge of the plant, all the lines, and the subsidiary equipment at each individual mining operation. This engineer is enabled to select a corps of operators and repair men from which a maximum efficiency may be secured. He also superintends the repair shop, which is run in connection with the central station, where repairing necessary for each mine is done at cost or a small margin of profit. The fuel is purchased from the individual coal mines, either by lowest bid or at a regular rate agreed upon by all the stockholders desiring to furnish coal.

This same scheme may be carried out in the development of a water-power, provided such a power can be secured within a reasonable distance from the mine and without too much installation cost. In this case fuel costs are nothing and running expenses are reduced to a minimum, the only limits to a water-power development being in the first cost and distance from points of use.

This cooperative central station plan offers many interesting possibilities and many factors of saving are introduced which are not possible in smaller plants used at individual mines. Considering first the initial cost we find that a plant having a capacity of 2,000 kilowatts may be built for less than four times the cost of a 500-kilowatt plant, thus making the cost per kilowatt installed less in the case of the large plant. It is possible, too, in developing a plant of this size, to secure the services of the best engineers, competent to work out carefully the many details of the installation, looking to the highest efficiency in upkeep and operation. Auxiliary generating units may also be installed, thus obviating the chance of interruption to service from breakdown, or any repairs that may be necessary.

The small operator is usually compelled to place in operation for his own use small generators, and engines usually of the slide-valve type and very inefficient. It is rarely the case that he considers it advisable to install more than one unit; thus he not only has inefficient operation to contend with but the possibilities of entirely closing his mine while small repairs are being made on some of the plant machinery. He rarely considers it necessary to secure the services of an engineer really competent to design and install the most efficient equipment, but contents himself with a plant installed almost any way by an ordinary operating man. His boilers are usually small and inefficient, the piping not properly covered, no superheaters, economizers, or feedwater heaters used, and the plant open at every point to uneconomical operation.

In considering the question of labor, we find that much time is lost or wasted by the engineer and repair men found at the small coal mining operation. This is due partly to the fact that there is not enough work to keep the men busy all the time and not enough men to do the work when special occasion arises. A great many of these operating men are not really in a position to know the best methods of repairing or how to test the plant to determine the economy of operation. The small repair shop wastes a great deal of material as well as time, and the workmen do not come in contact with a sufficient diversity of repair operations to be thoroughly conversant with the details of work becoming necessary at infrequent intervals. A shop of this type rarely has a sufficient stock of supplies or the tools necessary for good work.

We find, however, a very different state of affairs when the electrical service is secured from a cooperative central station. Here it is possible to use the utmost refinement in design, operation, and upkeep. The most efficient types of boilers and coal handling equipment can be used. Recording instruments can be installed which show the efficiency of production from day to day, and any small losses may be readily checked up and corrected. Large turbo units supplying alternating current can be placed in the engine room and a very high economy secured by the use of condensers and auxiliary apparatus. The plant being of large capacity, severe load peaks occurring at the individual mines do not affect it, and a comparatively even and steady operation is assured. Should it be necessary to stop one of the generating units for repairs or adjustments, the remainder of the plant can carry the load easily.

Viewing the question of labor in a large plant from a standpoint of efficiency, we find that one man can serve several boilers, especially if they are equipped with modern mechanical stokers. It is also possible to operate the engine room with very little more help than is necessary in the smallest plant. Assuming six mines, operating individually, there would be required, perhaps, 18 men, whose duties would be to fire the boilers, run the engines and generators, and make the repairs around the plant. Six men could easily do the same work in the central station furnishing the mine with power, and each man having enough to keep him busy continuously would produce more economically.

If a repair shop is operated in conjunction with the central station, it is possible to make repairs for all the mines in this shop with a marked saving in material used and in labor necessary. Another advantage accruing from a central repair shop is that better mechanics may be secured and kept busy; for having the work to do for all the mines, they very soon become experienced in nearly every class of repairs to be found in connection with such an operation. A large stock of material can be kept, obviating delays, and a fully equipped shop can be kept in operation.

Another advantage to the mine owner is that his power costs are in direct proportion to the power he actually uses, since he pays for electricity on the meter basis. Thus, if it is necessary for him to close down the mines, or reduce his output one-half, his power costs are reduced in like proportion.

When the cooperative method is used, the employment of an expert machinery inspector is possible, whose duty it is to pay periodical visits to all the individual mines,

inspecting their equipment with a view of keeping efficiency at the highest possible point, and also noting when repairs or adjustments are necessary on any of the machines. This inspector can furnish regular reports to each mine owner, showing the condition of his local equipment and when alterations or additions become necessary.

When several mines are operated in this manner the entire responsibility of power production and mechanical upkeep is shifted from the shoulders of the owner to the central plant, which performs all the necessary functions of engineer, repair man, and plant operator. The owner, instead of paying for labor and charging fuel to the operation of his boilers and engines, pays for the current used each month and pockets the saving.

After paying for the operation of the central station out of the money received from the consumer for power furnished, the remainder is placed to the account of earnings. At regular intervals dividends are paid to the mine owners out of the earnings, so that primarily each individual mine owner gets his power and his repairs at net cost, besides securing better and more reliable service, and reducing the trouble and worry of isolated plant upkeep to a minimum. The owner has the same outlet for refuse coal as when burning it himself, as he can furnish it to the cooperative plant at such a price as is agreed upon.

If water-power is available without too much expenditure, the fuel cost ceases to be a factor in production and the only items to be considered are labor, upkeep, depreciation, and the interest on the investment.

In the light of all these savings obtained in the use of a central plant owned by the mine operators, it is strange that no more developments along these lines have taken place, and it would be well for those mine operators who are located favorably for such an installation to carefully consider the matter in all its phases.

Large Armored Cable

*By F. J. Deemer, Jr.**

In the early part of 1913 it became necessary for the Lehigh Valley Coal Co. to supply more electric power to the inside workings of the Maltby colliery. This colliery is situated in the Wyoming Valley, on the west

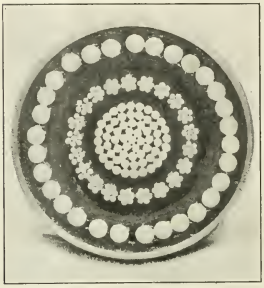


Fig. 1. Cross Section of Armored Cable

side of the Susquehanna River, about 4 miles above the city of Wilkes-Barre, Pa. The power was to be used to drive four separate inside hoists, three haulage locomotives, two large pumps, and five small pumps. At first glance this does not seem to be a difficult proposition, but the fact that the main switchboard is situated over 5,000 feet from the foot of the shaft rather complicated matters, as the problem of stringing a line of this length through the inside workings, suspending it solidly, and insulating it sufficiently so that there would be no danger from electric shock, presented so many difficulties that it seemed inadvisable to run a power line down the shaft and through the inside workings.

Mr. Charles Beers, electrical engineer of the Lehigh Valley Coal Co., finally decided that the best method was to run a pole line from the power house to a point directly over the inside workings, and drop a power cable through a bore hole 390 feet deep to the inside switchboard. With this in mind, he called into consultation the engineers of the Hazard Manufacturing Co., of Wilkes-Barre, as to the design of the power cable to be suspended in the hole. The cable was to be 400 feet long; a two-conductor cable, round, as light as possible, and of sufficient strength to support its own weight when suspended only from the top.

The cable finally designed is shown in cross-section Fig. 1 and longitudinally in Fig. 2. It consists of a central conductor, concentrically stranded, of 61 wires, each .0992 inch in diameter, equivalent to 600,000 circular mils, around which is a layer of vulcanized rubber compound, $\frac{1}{8}$ of an inch in thickness. Over this compound is wrapped a layer of insulating tape, and over this the second conductor, which is made up of 21 seven-wire strands, each individual wire having a diameter of .0641 inch, thus making up a second 600,000 circular mil conductor. Over this conductor is then placed a second belt of vulcanized rubber compound, $\frac{3}{64}$ of an inch thick, and a layer of insulating tape. The cable is strengthened with 31 No. 6 B. W. G., galvanized steel armor wires, bedded in a serving of jute over the tape, and protected on the outside with two layers of jute serving, saturated with a weatherproof compound, the fin-

*Abstract from an address delivered before the Lackawanna Chemical Society, in Wilkes-Barre, Pa., January, 1914.

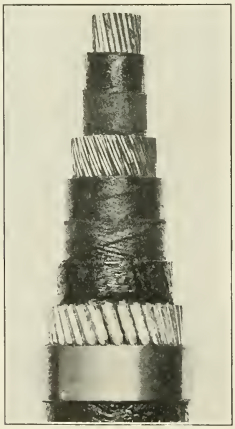


Fig. 2. Showing Construction of Cable

ished cable being more than 2½ inches in diameter and weighing approximately 8.86 pounds per foot.

As this cable is suspended in a bore hole, there was no possibility of supporting it from any point except the surface of the ground. The cable, about 400 feet long, weighs about 3,550 pounds and its support presented a problem, the solution of which is shown in Fig. 3. An iron pipe with an outside diameter of 10 inches was set up over the hole and a heavy concrete base and foundation was built around it, the concrete base extending about 8 feet above ground level, and the pipe extending 51½ inches above the top of the concrete to avoid the spring floods of the Susquehanna River.

Inside of the large pipe is placed another section of iron pipe, 6 inches outside diameter and extending 47½ inches to the bottom of the flange above the top of the 10-inch pipe, this second section of pipe being well braced and supported as shown. Resting on the flange of the upper pipe is a 12-inch square cast-iron plate, in the center of which is a round hole, slightly larger than the cable, and through which the cable is passed. The cable is then bound with a tight fitting, split, iron collar, of cross-section as shown, over which the armor wires are bent and held in place by a wrought-iron sleeve clamp, solidly bolted to hold the armor wires in place. The space surrounding the cable above the split collar and inside of the sleeve is filled with asphaltum to seal it and prevent the intrusion of water.

From this anchorage, the power cable is conducted to the pole line which carries four 0000 solid bare conductors, two for the power line and two for the return.

The construction of this whole system is of a most solid, permanent type. The cable presents some unusual features because of its size; and its load is 400 amperes, 500-volt direct current. It is a product of the Hazard Manufacturing Co., whose engineers have helped to solve many problems in power transmission.

International Congress of Social Insurance

The Committee on Organization of the International Congress of Social Insurance, which is to be held in Washington, October, 1915, completed its organization at its meeting at the Union League Club, New York, on January 31.

Already in the United States within 5 years there have been enacted laws in no less than 22 states changing the basis of liability for all industrial accidents; and in a large number of these states provision has also been made for insurance in state funds or in mutual funds under state supervision, either as the only method or with choice of companies. By the time the Congress convenes there will be a considerable volume of American experience, which, although new and incomplete, will be valuable for purpose of comparison with the riper results of European experience.

Inquiries concerning the Congress should be sent to the Committee on Organization, International Congress of Social Insurance, 141 Broadway, New York.

Fig. 3. Supporting Power Cable in Bore Hole

Recovering Oil and Waste

The Denver City Tramway Co. cleans the oil and waste used in the car journals in a tank 5 feet 6 inches long, 3 feet 6 inches wide, and 17 inches high, in which is a horizontal screen on which the picked waste rests. Clean, hot oil is poured over the waste, and after this oil has dripped away the waste can be used again. The oil used for washing is filtered and used again. About 150 pounds of journal and armature waste are worked through the tank every week, and the purchase of waste since December, 1912, when the plant was first used, has been very small. All car motors are oiled every 10 days.—*Electric Railway Journal, XLII, 62.*

PERSONALS

Mine Inspector F. W. Cunningham, of Somerset, Pa.; Superintendent Richard Maize, of the Merchants' Coal Co., of Boswell, Pa.; and Orville Kreger, of Boswell, Pa., have been appointed to hold examinations for mine foremen, assistant mine foremen and fire bosses in Somerset County, Pa.

The following is the new assignment of mine inspectors in the state of Illinois: First district, Hector McAllister; Second, Thomas H. Devlin; Third, Patrick Hogan; Fourth, David Thrush; Fifth, J. W. Starks; Sixth, Thomas Back; Seventh, Archibald Frew; Eighth, John Kaney; Ninth, William Hartman; Tenth, John McClintock; Eleventh, George Morgan; Twelfth, Joseph Fairburn.

W. D. L. Hardie, formerly colliery manager for the Alberta Railway and Irrigation Co., and later for the Diamond Coal Co., at mines near Lethbridge, has been appointed mayor and commissioner of finance and safety for Lethbridge, Alberta, Can., under the new commission form of government.

The mystery of the disappearance, some five years ago, of Edwin Joyce, superintendent of the Carnegie Coal Co.'s Glendale mine, was cleared up when his skeleton was found last month in some abandoned workings of the mine. The remains were identified by his watch which was with them. It is thought that he must have been overcome by gas, as he was thoroughly familiar with the mine.

Josiah Keeley, formerly superintendent of the Consolidated Coal Co., at Acosta, Somerset County, Pa., has been appointed general manager of the Cabin Creek Collieries Co., in West Virginia.

Charles F. Ice, formerly manager of the Millers' Creek division of the Consolidation Coal Co., has been made chief coal inspector for all the divisions of the company. He is succeeded as manager, by G. M. Gillette, formerly assistant general superintendent of the Elkhorn division.

A. Verner Orner has been appointed superintendent of the Panther Run Coal Co., at Pardus, Pa., to succeed Henry Redding, resigned.

Eli T. Conner, mining engineer, has moved his office from the Real Estate Trust Building to Room 1315 Stephen Girard Building, Philadelphia, Pa.

James D. Simpson, formerly superintendent of the mines of the Ocean Coal Co., at Herminie, Pa., has been appointed general superintendent of mines for the Berwind-White Coal Mining Co., with headquarters at Windber, Pa., the position formerly occupied by W. R. Calverly.

Heber Denman has been appointed to a new office as assistant general manager under Thomas Fisher, general manager of the Berwind-White Coal Mining Co. Mr. Denman has recently been in the coal mining business in Oklahoma, but was formerly with the Berwind-White Co., at Windber, when operations were first begun there.

John M. Roan has been appointed chief of the Safety Division of the Mining Department of Ohio.

Ralph Lockhard, superintendent of the Quemahoning Coal Co. mines at Ralphton, Pa., has been elected general manager of the Canadian Collieries, Ltd., whose mines are near Cumberland, B. C.

J. M. Forbes has been appointed safety inspector for the mines of the Provident Coal Co., in St. Clairsville, and Fairpoint, Ohio.

L. O. Mellinger, formerly with the Furnace Run Mining Co., has resigned his position to become superintendent at Bush Creek for the Rochester & Pittsburg Coal and Iron Co.

Morris Albaugh, of the Ohio Coal Mine Commission, has been appointed district mine inspector in the Hocking district of Ohio.

William L. Allen, formerly general manager of the Scranton Coal Co., Scranton, Pa., has been appointed general manager, succeeding John R. Bryden, resigned.

Arthur Neale, state mine inspector of the Irwin-Greensburg district, has resigned to take the position of inspector of the River Division of the Pittsburg Coal Co.

H. B. N. Louttit, general superintendent of mines of the Pittsburg Coal Co., has resigned to become general manager of the Vesta Coal Co., a subsidiary company of the Jones & Laughlin Steel Co., succeeding R. B. Drum, who has resigned.

Harry R. Miller, formerly inspector of mines on the Monongahela River for the Pittsburg Coal Co., has been appointed general superintendent of mines of Pittsburg Coal Co., succeeding H. B. N. Louttit.

D. H. Sullivan, former president of the Ohio United Mine Workers, has been appointed mine inspector for the Tuscarawas district of Ohio.

The Tye-Wheeler Coal Co. has been organized at Barbourville, Ky., to take over the mine in that district formerly operated by The Camp Coal Co. Mr. G. W. Tye was elected president of the newly formed company.

Gordon B. Late, of Bridgeport, Ohio, has acquired full control of the Irvington-Late Coal Co., operating near Hardman, W. Va. The name of the company has been changed to the Gordon B. Late Coal Co.

W. H. Goddard has been appointed general superintendent for the Southern Illinois Coal and Coke Co., succeeding Frank R. Fisher, retired. Mr. Goddard was formerly superintendent for the company at Hemlock, Ill.

The American Forestry Association has elected Henry S. Drinker, president of Lehigh University, and P. S. Ridsdale, as its president and secretary, respectively.

D. W. Drown, who has been managing the affairs of the Rocky Mountain Fuel Co, has been elected president of the company.

The Rocky Mountain Fuel Co., of Colorado, has created the new office

of general superintendent of mines and has appointed George T. Peart to the office.

E. E. Shumway, president of the Rocky Mountain Fuel Co., died in Denver, January 19, aged 51. He became ill following the explosion of December 17 at his company's Vulcan mine at New Castle, which caused the death of 37 men, and the worry incidental to the miners' strike is also believed to have affected his health.

R. S. Rogers, formerly of the Rogers-Garlick Coal Co., Cincinnati, Ohio, has been appointed assistant general manager of the Blue Ash Coal Co.

J. Edward Hibline, for a number of years with the National Coal Co., has resigned and has assumed the managership of the Chicago branch of the Quemahoning Coal Co., which has coal operations near Somerset, Pa.

At the annual meeting of the Southern Connellsville Coke Co., Connellsville, Pa., S. A. Carson, of Uniontown, was reelected general manager. The other officers chosen were F. E. Markell, president; S. J. Harry, vice-president; and J. R. Davidson, secretary-treasurer.

The Continental Coal Corporation, Pineville, Ky., announces the appointment of J. W. Dean, formerly mine foreman of its Barker Nos. 2 and 3 mines, as mine inspector for its mines.

Robert B. Maloney has been appointed general superintendent at Thomas, W. Va., for the Davis Coal and Coke Co., succeeding Harry Sharp, resigned.

Edward J. Corrigan was recently elected president of the Kansas City Midland Coal and Mining Co., succeeding the late Bernard Corrigan.

R. B. Brinsmade spent several weeks, during February, studying fuel possibilities in Central Jalisco, N. Mex.

Charles Dorrance, Jr., chief engineer of the Lehigh Coal and Navigation Co., has been made general manager of the Harwood Coal Co., at Harwood, Pa.

Pyrene as a Fire Extinguisher

*By Frank C. Perkins**

Pyrene is a combination of powerful gases maintained in liquid form without pressure and absolutely devoid of moisture. When pyrene liquid is subjected to a temperature of 200° F. or over, it is immediately transformed into a heavy, dry, cohering, non-poisonous, gas blanket. When the contents of one extinguisher are thrown on a fire 3,760 cubic feet of extinguishing gas is generated. The hotter the fire, the greater is the expansion of gas. In its liquid state pyrene contains neither acid nor alkali, and it does not deteriorate with age.

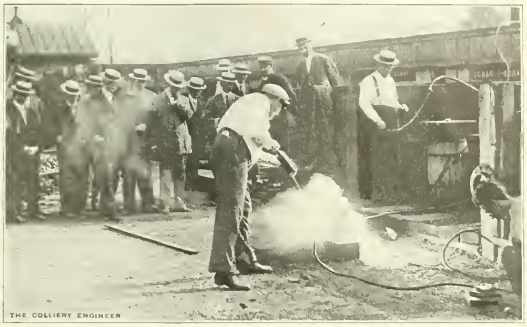


Fig. 1. Extinguishing an Arc of 600 Amperes

The fluid is dielectric up to 7,700 volts per millimeter and it will not conduct the electric current back through the extinguisher to the operator should the fluid be used on the arc. When an electric arc is formed and a fire started, pyrene by its rapid volatilization when thrown on the arc will have such a cooling effect it will extinguish the fire.

In Fig. 1 is shown an arc of 600 amperes being extinguished in the United States Railway and Electric Co.'s yard, Baltimore, by means of pyrene. Fig. 2 shows an arc of 2,000 amperes at 220 volts being extinguished by pyrene at the New York Edison Co.'s plant. Tests were made by Mr. Warren, electrician of the Delaware, Lackawanna & Western Coal Co., in which heavy steel rails (60-pound) charged with 1,200 amperes at 600 volts were used to form the arcs, which were broken by pyrene in from 1 to 3 seconds and did not reestablish. In one test an engineer attempted to break the arc with a 3-gallon chemical extinguisher. After making suitable preparations for insulation, he applied the stream from the chemical fire fighting apparatus to the arc and succeeded in extinguishing the fire, but so soon as the stream was taken away, the arc immediately reestablished. The tests for pyrene were so successful that the Lackawanna company now makes general use of the fluid wherever they have electrical apparatus and that is practically at every mine.

Among the many fires on which this liquid is efficient is subduing fires in coal bunkers. Fires of this sort are handled in the following manner: Perforated pipes of about 1 inch in diameter are forced into the coal pile as far as they will go; then the fluid is poured into the pipes. The amount of liquid required per ton of coal depends on the burning area. On this kind of fire the gases work slowly, but gradually penetrate the entire pile until they extinguish every burning ember, without destroying the heating properties of the unburned coal.

One peculiar feature, in connection with this fluid, which by the way is a

*Buffalo, N. Y.

discovery not an invention, is its ability to extinguish either oil or gasoline fires as readily as electric fires, due it is believed to the liquid cooling without crystallization and its gradually absorbing heat and by the gas blanket and liquid forming a combination which act in unison. The difficulty in extinguishing fires of this nature is due to the fact that the flame floats on the surface. Sand and solutions containing large percentages of water are not effective on this kind of fire because they are driven to the bottom of the burning oils and have a tendency to spread the area of the fire.

In using pyrene on oil fires, the flame is lifted off the burning substance by means of the intervening flexible blanket expanded from the liquid state by the heat. It is well known that any substance containing water will aggravate a fire under these conditions and make it burn more freely. Pyrene is also effective on fires of calcium carbide, which is now extensively used in the lighting of automobiles, motor boats, and houses.

The resistance of the fluid is 10,000 megohms or 10 billion ohms per cubic inch. It's dielectric strength is 250,000 volts per inch. Owing to its extremely high resistance this liquid will always be serviceable on the highest voltages commercially used and on all classes of electrical equipment. A stream of the liquid may be directed between the commutator and brushes or the armature and field or any moving rotary without in any way causing damage to the apparatus or injuring the operator. irrespective of voltage used. This applies as well to controller boxes, rheostats, transformers, switchboards, and all other electrical equipment.

It will break an arc caused by short-circuit and when broken the arc will not reestablish. At a test made for the Underwriters' Laboratories, arcs of 220 volts at 2,000 amperes were broken in 2 seconds, using about 2 ounces of liquid. These arcs did not reestablish. While the fluid is of great importance to electricians as a fire preventative it is also of much importance to coal mine operators outside of their electric power plants, in that it will cool hot journals and extinguish mine fires quickly and surely. Because of its vegetable composition, carbon dioxide and monoxide are evolved when the fluid is played on a fire, it is necessary therefore, that the firemen use oxygen

Fig. 2. Extinguishing an Arc of 2,000 Amperes

apparatus in fighting mine fires or fight them from the intake air-current.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Heaton's Annual, The Commercial Handbook of Canada, Heaton's Agency, Toronto. Price $1. Postage 12 cents. The 1914 edition of Heaton's Annual marks its first decade. Year by year, the book has been gradually developed to answer questions regarding the Dominion, until today it is almost indispensable to any financial or commercial firm having business relations with Canada. In the first 214 pages will be found the digest of the Customs Laws and Regulations, which includes all the memoranda and bulletins issued by the Department to the customs officials. The Shipper's Guide, gives population, banking accommodation, and railway connections in every banking town in the Dominion, a new feature which will be appreciated. The second half of the book contains a description of all towns in Canada of commercial importance, the existing industries, and special opportunities for new industries. Also a section covering agriculture, fur farming, commerce, education, finance, fisheries, forests, immigration, mining, population, professions, railways, game laws, water-powers, etc., making an admirable, up-to-date pocket encyclopedia.

Electrical Pocket Book, 1914, is just what its name indicates, a collection of electrical engineering notes, rules, tables, and data. The *Mechanical World*, of London, has been issuing this book yearly, keeping it at 200 pages of reading matter, by eliminating old material and replacing it with new. This year the book can be had from The Norman Remington Co., Baltimore, Md., for 25 cents.

Mechanical World, Pocket Diary and Year Book for 1914 is now in its 27th year. It contains 263 pages and a number of cuts explanatory of the text. It contains information on steam engines, turbines, gas engines, steam turbines, oil engine gas producers, besides tables and other material for the ready reference of the engineer. It can be had from The Norman Remington Co., Baltimore, Md., for 25 cents.

American Red Cross Abridged Textbook on First Aid. Miner's Edition. A Manual of Instruction by Major Charles Lynch and First Lieutenant M. J. Shields. This is a very different pamphlet from the first one issued by the Red Cross Society, in fact, it is a textbook nicely gotten up and illustrated. It contains 181 pages, 57 half-tone illustrations, also 19 plates. The book is printed by P. Blakiston's Son & Co., Philadelphia, Pa. Price 30 cents net.

No. 1, Vol. I, Penn State Mining Quarterly has made its bow to the public. It is very neatly gotten up and can be had for $1 per annum, by addressing Dr. E. S. Moore, Treasurer State College, Pa. There are four 1914 and three 1915 students on the staff. There are several interesting articles in this number which will be found of interest to miners and metallurgists.

Heating and Ventilation, 335 pages, 9×6, 137 half-tone illustra-

tions. Published by the B. F. Sturtevant Co., Hyde Park, Boston, Mass. This book is a continuation of the first edition on "Ventilation and Heating," published 25 years ago. The demand for the book was so great, that with each edition it was added to and improved until the present volume is not only a textbook, but a reference book of great value to architects, engineers, and students. One of its advantages is that any particular part of the contents can be found quickly and in one place. There are two parts to the book, Part I, containing the text, is divided into 12 chapters, while Part II is devoted to tables and useful information that applies to heating and ventilation of buildings.

The Sturtevant company place a small price on this book, and for information concerning this price, it will be necessary to write the company.

Bureau of Mines, Washington, D. C. New publications for distribution: Bulletin 66, "Tests of Permissible Explosives," by Clarence Hall and S. P. Howell, 1913, 313 pages, 1 plate, 6 figures. Bulletin 70, a preliminary Report on Uranium, Radium, and Vanadium, by R. B. Moore and K. L. Kithil, 1913, 101 pages, 4 plates, 2 figures.

Technical Paper 50, "Metallurgical Coke," by A. W. Belden, 1913, 48 pages, 21 figures. Technical Paper 54, "Errors in Gas Analysis Due to Assuming That the Molecular Volumes of All Gases are Alike," by G. A. Burrell and F. M. Seibert, 1913, 16 pages, 1 figure. Technical Paper 56, "Notes on the Prevention of Dust and Gas Explosions in Coal Mines," by G. S. Rice, 1913, 24 pages.

Iowa Geological Survey Bulletin No. 4. The Weed Flora of Iowa, by Dr. L. H. Pammel of the Iowa State College of Agriculture and Mechanic Arts. Collaborators, Charlotte M. King, J. N. Martin, J. C. Cunningham, Ada Hayden, and Harriette S. Kellog. Figs. 570, pages 912. Largest book on Weeds, and valuable. Address Iowa Geological Survey, Des Moines, Iowa.

Metal Statistics. The seventh annual edition of Metal Statistics for 1914 is published by the *American Metal Market and Daily Iron and Steel Report*, 81 Fulton St., New York. It is practically complete in the ferrous and non-ferrous metal fields, and an excellent reference book for buyers, dealers, and plant managers, of the metal industry. The American Metal Market Co. also issues *Steel and Metal and Digest* monthly, price $1.

The Sixteenth Edition of the Carnegie Pocket Companion represents fully the present status and the most approved methods in the art of steel construction. The first edition, issued in 1876 in connection with the Centennial Exposition at Philadelphia, gotten out by Carnegie Bros. & Co., then proprietors of the Union Iron Mills, at Pittsburg, dealt exclusively with iron. The last previous edition of the Carnegie Pocket Companion, issued in 1903, represented the status of the art at that date. In the 10 years which have elapsed the company has turned its attention to the manufacture of a diversified line of products, and it is no longer practicable to include in one publication all of the various shapes now made. In the present publication, therefore, only those rolled shapes are illustrated which are deemed most suitable for bridge, building, car, and ship construction; and the tables given are intended for users of materials entering into such constructions only. The book has been rewritten from beginning to end, and users of the previous edition, 1903, will find many changes, among which are the following:

The inclusion of the American Society for Testing Materials' standard specifications for structural and other steels and the American Bridge Co.'s specifications for workmanship.

The addition of tables and data on concrete reinforcing bars.

New treatment of the subject of stresses in beams.

New flexure formulas and the computing of the safe loads of beams, channels, angles, and tees, on a basis of a thousand pounds instead of tons.

The data on floor construction are new and cover terra cotta arches, as well as reinforced concrete.

The data on roofs and roofing have been extended to cover various forms of trusses in current use, and are followed by tables giving safe loads and unit stresses for timber beams and columns.

While, as compared with the 1903 edition, this book contains only some 80 pages additional, yet, owing to the omission of certain profile pages, the increase in the size of the page and the condensation of the material, the amount of engineering data in the book has been practically doubled. Copies may be had by draftsmen, engineers, and others at the price of $1 per copy, on application through any of the offices of the company.

The Interferometer

To estimate the amount of firedamp present in colliery air, a portable instrument has been devised by Carl Zeiss, of Jena, which depends on the properties which gases possess of refracting light in varying degrees, according to their chemical composition. This property was demonstrated many years ago by Lord Rayleigh, but only recently has it been applied to the determination of the presence of firedamp in mines. The optical analysis of gases was introduced, and developed, by Herr Geheimrat Haber, of Dahlen, while, comparatively recently there appeared in *Glückauf* (No. 2, 1913) an account by Dr. E. Kuppers, concerning the chemical and optical analysis of samples of air containing methane, which were made in the laboratories of the Westfalische Berggewerkschaftskasse, at Bochum, and it appears to be sustained that technical analysis of gas by the interferometer method can be very favorably applied to the estimation of firedamp.

The modern interferometer is made both in the laboratory and portable form, and Fig. 1 gives a cross-sectional diagram of the portable arrangement. This is of an upright

cylindrical pattern of about 10 centimeters diameter and 50 centimeters long, the only part which can be detached from it being a small accumulator. With gas chambers 10 centimeters long, it reads percentages of CO_2 and CH_4 with a degree of accuracy within .1 to .2 per cent., and the accuracy of which the instrument is capable can be increased, if necessary, to a certain extent. The weight of this instrument is about 11 pounds, and it may be applied in practically any position. The indications are obtained by correcting the degree of deviation which a ray of light passing through the atmosphere of firedamp obtains as compared with its deviation when passing through an ordinary atmosphere, by the revolution of a compensating plate which returns the indicator to a position of zero. In Fig. 1 the cross within the tube B shows the position of the source of illumination, which is a small Osram lamp supplied with current from the accumulator, and screwed into a cylindrical fitting within the slit tube B and clamped therein. The arrows show the path of the rays, and that the parallel pencil of rays splits, one portion passing through the gas chamber, and the other through the comparison chamber. At S is a mirror with a double slit, K is a tilting lever, M a micrometer drum, and Z the revolution counter of the compensator. In the zero position of the apparatus, when both gas chambers are filled with the same substance, the field as seen from the eyepiece will appear to be divided into two white halves by a fine and dark horizontal line and both halves exhibit identical diffraction spectra. The upper diffraction spectrum does not undergo any changes when the adjustment of the instrument is altered, as it is the basis for measurements and corresponds to the cross-lines of an eyepiece and marks the zero position. The lower spectrum, on the other hand, suffers a lateral displacement when the chamber is filled with the gas and passes into the dark portion of the field. The process to obtain the reading consists in simply turning the micrometer screw and compensator until the displaced bands in the lower system return to the white portion of the field and the two dark bands at the middle are accurately continuous with the corresponding and similar bands of the upper system. No attention need

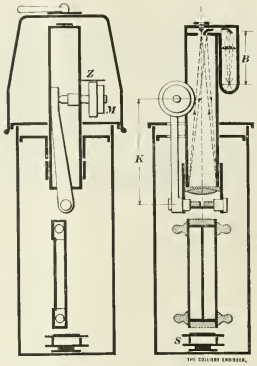


Fig. 1. The Interferometer

be paid to the particolored bands on either side of the black bands. There is no difficulty in setting the movable band so as to be accurately continuous with the black band, and the resulting readings are remarkably accurate and uniform. The gas chamber is so adjusted that the line of separation between the two spectra is very narrow, no wider than one of the black bands in the middle.

The filament of the lamp is so arranged that it is at right angles to the axis of the micrometer screw and the compensator, and the fitting is moved to and fro until the horizontal strip separating the two spectra is as narrow as possible. The lamp is used only during those minutes that the compensator is being set.

In the tests made at Bochum a bottle containing one-tenth of a liter of water and closed by two taps was taken to the spot in the pit where the percentage of mine gas was to be determined; as the water ran out, the gas was drawn in. Samples thus obtained were forwarded to the laboratories. A portion of the gas required for the optical examination with the interferometer, which was 50 cubic centimeters, was freed of carbon dioxide by absorption tubes, and dried, after which the gas was passed from the exhaust chamber to the interferometer. Immediately after the sample had been passed in, the "wandering" of the interference strips was measured, and marked by means of the compensating screw, which was gauged once and for all, according to the percentage of methane. The results of the optical analysis were shown in tables, together with those of the chemical analysis, and the differences between both were as follows:

With 26 samples .00 to .02 per cent. of methane; with 16 samples .03 to .05 per cent. of methane; with 12 samples .06 to .09 per cent. of methane; with 4 samples over .10 per cent. of methane.

The average difference between the chemical and optical analysis is ± .04 per cent. For further reference to the use of the laboratory interferometer, a communication by F. Haber and F. Lowe, in the Zeitschrift f. angew. Chemie XXIII, S. 1393, 1910, may be consulted. It is interesting to note that in the method detailed by Doctor Kuppers, no difficulty was experienced in working for hours, and partly in a high percentage of firedamp, in one case rising to 15 per cent. of CH_4. One measurement lasted about 1 minute. There appears to be every reason to believe, therefore, that this instrument provides an authoritative standard against which the methods of estimating firedamp at present in existence may be accurately checked, and its portable form, therefore, is of particular value and interest to mining engineers.—*J. A. S.*

Useful Information

One United States gallon of water measures 231 cubic inches or .13368 cubic foot, and weighs 8.334 pounds.

One cubic foot of water contains 7.4805 United States gallons and weighs 62.335 pounds at 62° F.

PRIZE CONTEST

For the best answer to each of the following questions we will give any books on mining or the sciences related thereto, now in print, to the value of $3.

For the second best answer, similar books to the value of $2 will be given.

Both prizes for answers to the same questions will not be awarded to any one person.

1. The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.
2. Answers must be written in ink on one side of the paper only.
3. "Competition Contest" must be written on the envelope in which the answers are sent to us.
4. One person may compete in all the questions.
5. Our decision as to the merits of the answers shall be final.
6. Answers must be mailed to us not later than one month after publication of the question.
7. The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what books they want, and to mention the numbers of the questions when so doing.
8. In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.
9. Employes of the publishers are not eligible to enter this contest.

Questions for Prizes

58. State what factors determine the size of a hoisting shaft for a coal mine. What size would you adopt for working a coal seam lying 300 feet below the surface, the seam is 6 feet thick with good roof and bottom? Assume the mine output per day to be 1,200 tons in 10 hours.

59. Describe the manner of setting a valve of an engine. State, also, in what case you would use an early cut-off, and give sketch showing the position of the valve at the time of cut-off on the following stroke of the engine.

60. A shaft on a hill is 150 feet deep and is making 4,000 gallons of water per hour. Near the mouth of the shaft is a ravine descending to a river 100 feet below the level of the shaft bottom. How would you handle this drainage problem?

61. Determine the efficiency of a pump that is discharging 1,200 gallons of water per minute, under a vertical head of 250 feet, at an expenditure of 125 horsepower. What should be the diameter of the discharge and suction pipes of this pump?

34-8—6

Answers for Which Prizes Have Been Awarded

Ques. 50.—How would you find the distance between two shafts which are divided by a river? No other instrument than a tape is available.

Ans.—Go a sufficient distance from No. 1 shaft, Fig. 1, on a line

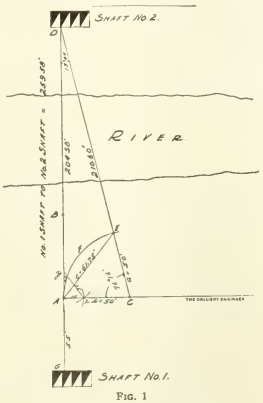


Fig. 1

toward No. 2 shaft, to clear the head-frame supports, etc., and set a stake A. Then select one of the guides, a corner, or some definite point on shaft No. 2, and set another stake B, on line between A and this point.

Then from A measure off 20 feet on the line AB. With A as a center, and a radius Ax equal to 15 feet, describe a short arc of a circle. Then with y as a center, and with a radius equal to 25 feet, again describe a short arc of a circle, intersecting the first, and draw a line from A, through the intersection of the two arcs x. The line Ax will be perpendicular to AB, and the angle yAx will be a right angle. Any multipliers of the figures 3, 4, 5 may be used in the construction of a right angle.

Project the line from A to x, any distance; say 50 feet, to C. With C as a center, describe an arc, stopping at a point E, on line of C to D, which is on shaft No. 2 selected in determining line ABD.

From E, measure the chord AE of the arc AFE, and we find it to be say 61.75 feet.

Then with the three known sides AC = 50 feet; CE = 50 feet; and AE = 61.75 feet, we solve the oblique triangle AEC, to find the angle C.

$$c^2 = a^2 + e^2 - 2ae \cos C.$$

$$\cos C = \frac{a^2 + e^2 - c^2}{2ae}$$

Substituting,

$$\cos C = \frac{50^2 + 50^2 - 61.75^2}{2 \times 50 \times 50}$$

$$\cos C = .2374$$

$$C = 76^\circ\ 16'$$

DA is tangent to the circle AFE, and A is a right angle.

$D = 180° - (76° 16' + 90°)$. The sum of the angles of a right triangle being equal to two right angles;

$D = 13° 44'$.

Solving the right triangle CAD to find the side AD

$$\tan D = \frac{CA}{AD}$$

$$AD = \frac{50}{\tan 13° 44'} = \frac{50}{.2444} = 204.58'$$

Ques. 51.—An endless rope has to be driven by an electric motor. The rope wheel has to make seven revolutions per minute and the motor makes 1,000 revolutions per minute. Show, by sketches, how you would arrange the intermediate gearing, giving diameters of gear-wheels.

Ans.—In Fig. 2, A is the motor pinion, B is a spur gear keyed to

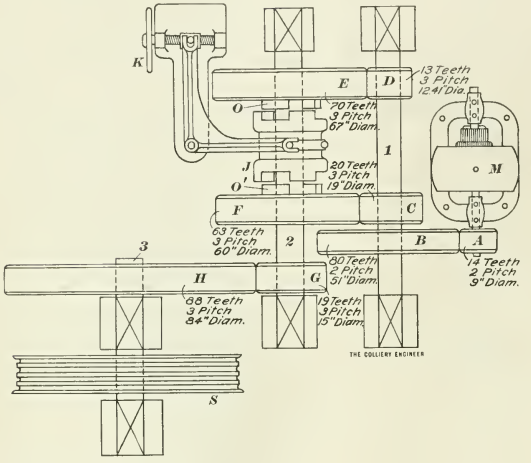


Fig. 2

Then, to prove the foregoing calculations:

$$\text{Sine } A = \frac{AC}{DC}; DC = \frac{50}{\text{sine } A}; DC = \frac{50}{.2374};$$

$DC = 210.6'$

Further,

$$DC^2 = AC^2 + AD^2$$
$$210.6^2 = 50^2 + 204.58^2$$
$$44{,}352+ = 44{,}352+$$

Then project the line BA to shaft No. 1 at G, which we find to be, say, 55 feet.

$GA + AD$ = distance from No. 1 shaft to No. 2 shaft = 55 + 204.58 = 259.58 feet.

Jos. H. Jones

Shamokin, Pa.

Second Prize, R. A. Ramsey, Pittsburg, Pa.

shaft 1 to which pinions C and D are also keyed. E and F are spur gears running loose on shaft 2. G is a pinion keyed to shaft 2, and H is a spur gear keyed to shaft 3, on which is the driving sheave S for the endless rope. On gears E and F are jaws O and O' into which the clutch J can engage.

J is a three-jaw clutch which is keyed on shaft 2 so it can be moved by the shifter K to engage either E or F. In the above arrangement the gear can be changed to run the sheave S either 7 or 11.93 revolutions per minute as follows. When the clutch J is moved, so as to engage gear E we have the following train of gears: Drivers A 14 teeth, D 13 teeth, and G 19 teeth; driven, B 80 teeth, E 70 teeth, and H 88 teeth. The motor makes 1,000 revolutions per minute, therefore, revolutions per minute of $S = \frac{1{,}000 \times 14 \times 13 \times 19}{80 \times 70 \times 88} = 7$ revolutions per minute.

Now, if the clutch is moved so as to engage F, we have as follows: drivers A 14 teeth, C 20 teeth, and G 19 teeth; driven B 80 teeth, F 63 teeth, and H 88 teeth, therefore, revolutions per minute of $S = \frac{1{,}000 \times 14 \times 20 \times 19}{80 \times 63 \times 88}$ = 11.93 revolutions per minute. We have two of the above installed, one handling on an average of 2,250 cars per day.

Charles R. Drum

California, Pa.

Second Prize, D. H. Abram, Johnstown, Pa.

Ques. 52.—Explain the principal points requiring your attention in laying out 3 miles of colliery railway over undulating land. What is the minimum radius of curve that you would adopt, assuming that large locomotives of standard gauge had to work thereon?

Ans.—The principal points to be observed are: To keep the road as straight as the contour of the land will permit, allowing a maximum grade for short distances of 3 per cent. To have as few cuts and fills as possible, and to make the cuts, as far as possible, just large enough to make the necessary fills. Curves may be used where the cost of cuts and fills exceeds the cost of laying curves around the hill, either due to height or length of cut.

Where curves are necessary, the radius should not be less than 250 feet, especially after leaving the mine sidings, where higher speeds will be attained.

Where a stream is to be negotiated, this will partly fix the position of the railroad. Suitable crossings, and as few as possible, should be made.

The steel should not be less than 60 pounds per yard, or over 90 pounds.

If gravity mine sidings are used, the grades (especially where winter temperature is below zero), should be, high line, 1.6 per cent. immediately above the tipple, and at loader 2.2 per cent.; below tipple, 2 per cent. to the scales and for standing room beyond.

Tracks should be well anchored above the scales to avoid creeping down and binding on the scales.

E. S. F. Huntrods

Taber, Alberta, Can.

Second Prize, Irvin Frailey, Windber, Pa.

Ques. 53.—Make a sketch of a fan drift in which provision is made for reversing the ventilation without having to reverse the fan.

Ans.—Fig. 3 shows plan and elevation of fan drift with doors so

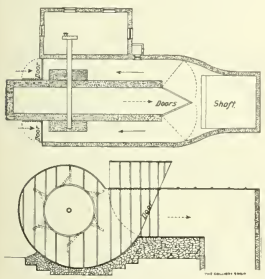


Fig. 3

arranged that the direction of the air can be reversed without reversing the fan. When the doors are as shown, the fan is working as an exhaust and the air is moving in the direction shown by the full line arrows.

In order to reverse the air, the doors are placed in the positions indicated by the dotted lines; the air will then move in the direction indicated by the dotted arrows. The fan then acts as a force fan.

Jas. J. Walsh

436 S. River St., Wilkes-Barre, Pa.

Second Prize, Moses Johnson, Taber, Alberta, Can.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Pumping

Editor The Colliery Engineer:

Sir:—We have a triplex Deming pump 5 in. × 6 in., which is connected to a 3-inch suction and 4-inch discharge. Suction line is about 1,000 feet in length, on the end of which we had three lengths of 4-inch pipe 20 feet long which did not work properly, in fact, the water was gaining on us. We decided to take the 4-inch pipe off and replace the same with 3-inch pipe, which we did, and the result was that the water was taken out in 4 days. I contended that the vacuum created by the pump through the 3-inch line was not great enough to draw a 3-inch stream. I might state that there was also an ell and nipple on end of each kind of pipe into the pump, but as soon as the 3-inch ell and nipple was placed on the end of the 3-inch line, conditions changed for the better.

W. H. Barker

Lafayette City, Pa.

Influence of Earthquakes

Editor The Colliery Engineer:

Sir:—Inasmuch as there seems to be a determined effort, in one quarter, at least, to attribute outflows of gas in American coal mines to earthquakes in the antipodes, I would respectfully suggest that the American Geological Society, at its next meeting, appoint a committee to investigate the likelihood of an earthquake in Kamschatka, or some other distant point, causing "brain storms" in New York.

N. G. Near

Birmingham, Ala., Feb. 9, 1914.

Capacity of Car

Editor The Colliery Engineer:

Sir:—Please calculate for me how many bushels of coal a mine car, of the form and dimensions shown in Fig. 1, will contain.

Robert H. Patton

Hostetter, Pa.

Ans.—Consider the car to be divided into two parts, the upper as a

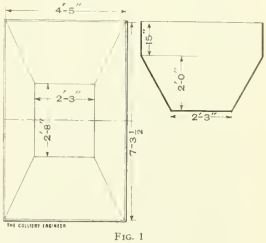


Fig. 1

rectangular prism and the lower as an inverted frustum of a pyramid.

The volume of the upper part = base × altitude = $53'' \times 87\frac{1}{2}'' \times 15''$ = 69,562.5 cubic inches.

To find volume of a frustum of a pyramid.

Assume: B = area of large base;
b = area of small base;
H = altitude.

$$\text{Volume} = \frac{H}{3} = (B+b)\sqrt{(B \times b)}$$

But $B = (53'' \times 87\frac{1}{2}'')$;
$b = (32'' \times 27'')$;
$H = 24''$.

$$\text{Volume} = \frac{24}{3}\,(4{,}637.5 + 864 + \sqrt{864 \times 4{,}637.5}) = 8(4{,}637.5 + 864 + 2{,}001.6) = 8 \times 7{,}503.1 = 60{,}024.8$$

cubic ches.

Total volume then = 69,562.5 +60,024.8 = 129,587.3 cubic inches.

A U. S. bushel = 2,150.42 cubic inches, therefore the car contains $\frac{129,587.3}{2,150.42} = 60.3$ bushels.

Haulage Problem

Editor The Colliery Engineer:

Sir:—Herewith is a proposed solution of the problem in haulage presented by "Mining Engineer" in the February Letter Box:

He states that there has been difficulty in working out the distribution of cars. Electric gathering requires more cars than mule haulage because of the greater number of cars per trip. With electric gathering, the loading and dumping of each car twice per day, under the conditions described, would be good work. This for 500 cars per day would require 250 mine cars.

Five hundred cars per day from six gathering locomotives is not impossible of achievement, but it is unlikely that any mine manager would succeed in having it done day after day. A gathering motor should handle from 60 to 100 cars per day, depending on proximity to side track and working rooms, actual voltage in the working place, condition of motor, condition of track, grades, and more than anything else, on the ability of the crew. I should, therefore, recommend two more gathering locomotives.

Five hundred cars per day with one haulage motor at the rate of 25 cars per trip means a round trip from about four partings every half hour. Another haulage motor should be secured by all means.

In the meantime, to maintain an output while purchasing his new equipment, the writer would install a telephone at about the third butt entry off the first face entry. All motors would be required to secure right-of-way on the main lines from the telephone boy or dispatcher. An intelligent trapper should handle the telephone at this point, thus saving extra expense. All motors gathering from the first five panels would do their own hauling from the tipple. An alternative to this plan, and perhaps a better one, would be for the motor which is "foot-loose" to do the hauling. For instance the gathering motor comes out with its trip and finds no empties. Instead of waiting for them, it secures the right-of-way and proceeds to the tipple. On the other hand if the big motor has placed empties for it, it goes back in and places them.

This system has been used with success by the writer. It means that with insufficient equipment, there must be quick trips, short trips, and the keeping of all motors and cars constantly in motion.

The writer does not like side tracks for electric haulage though some men do. The best method is to use No. 1 and No. 2 rooms on the butt entries for partings. This gives two tracks besides the main line, which are necessary for efficient work in electric gathering, and they are secured without any expense or weakening of pillars.

We have a report system showing the daily performance of each motor. This report shows the number of cars gathered, delays, cause therefor, repairs wanted, etc., which enables one to place the responsibility when proper work is not being done.

In conclusion I will say that if I had that mine to work and was expected to get 500 cars per day, I would work a section or two at night.

Subscriber

Editor The Colliery Engineer:

Sir:—In answer to "Mining Engineer" in your February issue it would seem that his equipment should be sufficient to produce five hundred 2-ton cars per day without much effort. I offer the following plan for distributing the cars and running the motors:

Place one 4-ton motor to haul all coal from the four main entries, also all coal from the two short entries. Have this motor deliver the trip to the main line motor at the face entry that turns off 50 feet inside of the drift mouth. This will allow the 12-ton motor to be placed on the 2,500-foot face entry regularly. I take it from his communication that the balance of the 100 places, which would be 94, are in the face entry, or butt entry turned off face entry. This would leave five 4-ton motors to gather the coal for the main line motor. This motor should make three trips per hour nicely, or 30 trips per day, which at an average of 25 cars per trip would give an output of 750 cars in 10 hours; one hundred seventy-five 2-ton cars should be a plenty if the men are placed as I understand from his letter, and the cars placed as follows: Six cars, one at face of four main entries, and two at face entries; six in full trip on the way out; six in empty trip on the way in; total, 18 cars. This leaves 157 cars to run the balance of the mine, and these should be placed as follows: Entry train for motor on tipple, 25 cars; full train for motor on side track, 25 cars; entry cars in places for men to load, 80; entry cars for timber outside, 7; total, 137. The 80 cars at face for men to load would give each man two trips to load his car. Each car should be loaded good and big, as big cars are hauled in the same time as small ones. It is the big cars that boost the tonnage, and I always insist on my drivers hauling nothing that is not loaded full and topped. I hope these few suggestions may be of some use to "Mining Engineer."

Driver Boss

Editor The Colliery Engineer:

Sir:—It appears to the writer from the data given on haulage problem in your February issue, that "Mining Engineer" needs about 25 more working places or 125 in all. As a rule 8 tons is about the average coming from one room and this will produce the desired five hundred 2-ton cars.

To haul this number of cars to the tipple he should have another haulage motor, and then, provided the partings on the cross-entries are not too far apart, two gathering motors on an entry should keep the haulage motors supplied with loaded cars.

Ohio Mine Boss

Answers to Examination Questions

Questions Selected from Those Asked at the Examination for Mine Manager, Mine Examiner, and Hoisting Engineer, Held at Springfield, Ill., September 8 and December 15, 1913.

Note.—The numbers do not correspond with those of the Examination Questions as asked. After each question, is given the nature of the examination. M. M.=Mine Manager; M. E.=Mine Examiner; H. E. =Hoisting Engineer.

Ques. 1.—What horsepower will an engine exert, when yielding 60 per cent. of duty, to move 100,000 cubic feet of air a minute; the water gauge stands at 1 inch? (M. M.)

Ans.—The horsepower actually required to move the air may be found by substituting in the formula, H. P. $= \frac{q\,p}{33{,}000} = \frac{100{,}000\times(1\times5.2)}{33{,}000}$ =15.758. In the formula, q=the quantity of air in circulation in cubic feet per minute, and p=the pressure in pounds per square inch=water gauge×5.2.

Since but 60 per cent. of the power is exerted in moving the air, the total horsepower developed by the engine is 15.79÷.60=26.263.

Ques. 2.—In a 12-inch column pipe 450 feet long on a 42-degree pitch; (*a*) What would be the pressure per square inch at the bottom? (*b*) What would be the total weight of water in tons? (M. M.)

Ans.—(*a*) The vertical height of the water above the bottom of the pipe, or the head producing the pressure=length of pipe×sin angle slope =450×.66913=301.11 feet. Since the weight of a prism of water 1 foot high and 1 inch square is .434 pound, the pressure per square inch upon the bottom of the pipe is 301.11×.434 =130.68 pounds.

(*b*) The area of the cross-section of this pipe, since 12 inches=1 foot, is $1^2\times.7854=.7854$ square foot. The number of cubic feet in the pipe is 450×.7854=353.43. At 62.5 pounds per cubic foot, this volume of water will weigh (353.43×62.5)÷2,000 =11.045 tons.

Ques. 3.—With a water gauge of .4 inch, a fan is making 80 revolutions per minute. We are producing 35,000 cubic feet of air per minute. What should we produce with a water gauge of .8 inch? (M. E.)

Ans.—Two cases may arise. (*a*) The common case where the increase in the pressure is due to an increase in the length of the workings, and where, the power remaining constant, it is desired to know what the fan can be counted upon to produce when working against the resistance of the longer airways. Here the decrease in the quantity of air in circulation is directly proportional to the increase in pressure or, what is the same thing, to the increase in the water gauge, and $Q=35{,}000\times\frac{.4}{.8}$ =17,500 cubic feet per minute. (*b*) In the second case where the fan is speeded up and the quantity of air increased until the water gauge reaches .8 inch, the increased quantity is in proportion to the square root of the relative increase in the pressure (water gauge), and $Q = 35{,}000 \times \sqrt{\frac{.8}{.4}} = 35{,}000 \times \sqrt{2}$ =35,000×1.414=49,490 cubic feet.

Ques. 4.—What load will break a white oak timber 8 in.×12 in. and 15 feet between the supports, if the load is equally distributed along the length? (M. M.)

Ans.—In the case of a uniformly distributed load, the weight required to break a beam supported at both ends is found from the formula, $W=\frac{16\,S\,I}{L\,D}$. In this, W=the total load in pounds; S=unit strength per square inch of the wood, which may be taken as 8,500 for white oak; I=the moment of inertia of the cross-section of the beam which is presumed to be placed with its 15-inch cross-dimension vertical; and L and D are, respectively, the length and depth of the beam in inches, which in this case are 15×12=180 inches, and 12 inches. If b=the breadth of the beam=8 inches, the moment of inertia may be found from

$$I=\frac{b\,d^3}{12}=\frac{8\times12^3}{12}=1{,}152$$

Hence, $W=\frac{16\times8{,}500\times1{,}152}{180\times12}$ =72,533 pounds. This is the total load required to break the beam. Since it is uniformly distributed, the breaking load per running foot will be, 72,533÷15=4,735 pounds.

Ques. 5.—If 20,000 cubic feet of air pass in a circular airway of 12 feet diameter, what quantity will pass in one 6 feet in diameter? (M. M.)

Ans.—The answer to this question will depend upon the assumptions made. If we assume that the velocity is unchanged, the question is one of determining the quantities carried by two airways of known dimensions, and the quantities vary directly as the squares of the diameters, or $\frac{x}{20{,}000}=\left(\frac{6}{12}\right)^2=\left(\frac{1}{2}\right)^2=\frac{1}{4}$, from which x=20,000÷4=5,000 cubic feet per minute.

If it be assumed that the pressure is unchanged, the quantity of air in circulation is proportional to the square root of the fifth power of the

diameter; or the square of the respective quantities is proportional to the fifth powers of the respective diameters. If the quantity of air circulating in the smaller airway is x, the ratio is, $\left(\frac{x}{20{,}000}\right)^2=\left(\frac{6}{12}\right)^5=\left(\frac{1}{2}\right)^5$. From this, $\frac{x^2}{400{,}000{,}000}=\frac{1}{32}$, and by transposing and dividing, $x^2=12{,}500{,}000$. By extracting the square root, x = quantity in circulation in the smaller airway = 3,535 cubic feet per minute.

Ques. 6.—What is the pressure per square inch in a boiler; the whole length of the lever being 32 inches, the distance between the fulcrum and the valve, 4 inches, the diameter of the valve being $2\frac{1}{2}$ inches, a weight of $30\frac{5}{8}$ pounds being placed at the end of the lever? (H. E.)

Ans.—The weight of the lever, valve, etc., are neglected. The pressure of the steam multiplied by the distance through which it acts must be equal to the weight at the end of the lever multiplied by the distance through which it acts. Calling the total steam pressure on the valve S, $S\times4=30\frac{5}{8}\times32$, or $4S=980$, and $S=245$ pounds. This is the total pressure on the valve which has an area of $.7854\times(2\frac{1}{2})^2=4.90875$ square inches. Hence, the pressure per square inch is equal to $245\div4.90875=49.91$, say, 50 pounds.

Ques. 7.—How many acres, and tons, of lump coal are there in the following described piece of land: Commencing at the southeast corner, running due north 600 feet, thence east 75 feet, thence north 450 feet, thence west 600 feet, thence south 450 feet, thence west 525 feet, thence south 600 feet, thence east 1,050 feet, to the place of beginning, allowing 27 cubic feet to 1 ton; the coal is 4 feet 7 inches high? (M. M.)

Ans.—The shape and dimensions of the tract are shown in Fig. 1. The field consists of two parallelograms with dimensions of 1,050 ft.×600 ft. and 450 ft.×600 ft. The areas of the two parts are

1,050×600 = 630,000 square feet.
450×600 = 270,000 square feet.
Total area = 900,000 square feet.

(*a*) The number of acres in the tract is $900{,}000\div43{,}560=20.66$ acres.

(*b*) To find the number of tons of coal in the tract, the volume, or the number of cubic feet in the seam, must be determined. Volume = area in square feet × thickness = 900,000 × $4\frac{7}{12}$ = 4,125,000 cubic feet. Since 27 cubic feet weigh 1 ton, there are in

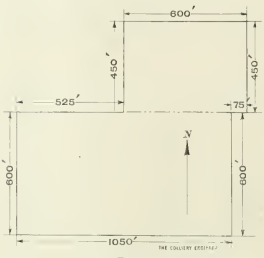


Fig. 1

the tract $4{,}125{,}000\div27=152{,}777$ tons.

Ques. 8.—The hand of an anemometer turns 3.5 times a minute. The airway is 6.5 feet high and 8.25 feet wide. What is the velocity of the aircurrent and what would the velocity (quantity?) be if you allow 3 per cent. for resistance of anemometer? (M. E.)

Ans.—The question appears to be wrongly stated, as it twice asks for the velocity. It appears probable that the velocity and quantity are wanted since the size of the airway is given, something that is not concerned in velocity determinations. The velocity of the air as indicated by the anemometer is $3.50\times100=350$ feet per minute. The actual velocity is $350\div(1.00-.03)=350\div.97=360.83$ feet.

The area of the airway is $8.25\times6.5=55.625$ square feet, and the volume of air passing is $360.83\times55.625=20{,}071.17$, say, 20,000 cubic feet per minute.

Ques. 9.—What is the breaking strain of a steel wire rope $1\frac{1}{8}$ inches? (H. E.)

Ans.—Assuming that the question refers to a 6×19 (six strands of 19 wires each) standard hoisting rope, the manufacturers give the breaking strain as 38 tons for a crucible cast-steel rope, which is the standard, and 43 tons for an extra strong crucible cast-steel rope. The safe working load under a factor of safety of 5 would be 7.6 tons and 8.6 tons, respectively, for ropes of the above materials. It is better to refer to the manufacturers' tables than to attempt to calculate the strength of the ropes by means of the formulas ordinarily given. The formula for calculating the strength of a 6×19 crucible cast-steel hoisting rope is, $S=34\ d^2=34\times(1\frac{1}{8})^2=43$ tons. This is 5 tons more than the makers allow for the same rope. Similarly, the formula for the total strength of a 6×19 extra strong crucible cast-steel rope is $S=39\ d^2=39\times(1\frac{1}{8})^2=50$ tons (about), which is 7 tons more than the manufacturers consider right.

Ques. 10.—What is the use of having a flywheel on an engine? (H. E.)

Ans.—The object of the flywheel is to carry the engine over the dead center, taking up power in the middle of the stroke and giving it out at the end of the stroke so that the engine may run steadily and uniformly. If the flywheel is too light the engine will not run uniformly; will have what may be called a lunging motion, and may fail, if the load is heavy, to carry over the dead center. On the other hand, if the flywheel is too heavy, excessive power will be required to start and stop the engine.

Ques. 11.—With 10 horsepower we are getting 20,000 cubic feet of air. What horsepower will be necessary to produce 45,000 cubic feet? (M. E.)

Ans.—The powers are proportional to the cubes of the quantities. Calling the horsepower required to produce 45,000 cubic feet, y, we have $y:10=45{,}000^3:20{,}000^3$, or

$$y=10\times\left(\frac{45{,}000}{20{,}000}\right)^3=10\times(2.25)^3$$

$=10\times11.3906=113.91$ horsepower.

Ques. 12.—Calculate the quantity of air passing per minute, the pressure in pounds per square foot, the water gauge and horsepower, under the following conditions: The airway is 5 feet by 8 feet and 4,000 feet long,

the anemometer indicates a velocity of 200 feet. (M. M.)

Ans.—The volume of air passing per minute is equal to the area of the airway in square feet multiplied by the velocity of the current in feet per minute, or $(5\times8)\times200=8,000$ cubic feet.

The rubbing surface of the airway is $s = (5 + 5 + 8 + 8) \times 4,000 = 26\times4,000 = 104,000$ square feet. From the formula, $p=\frac{k\,s\,v^2}{a}$,

$$p=\frac{.00000002\times104,000\times(200)^2}{5\times8}$$

$$=\frac{83.2}{40}=2.08$$ pounds per square foot, pressure.

The water gauge is equal to $2.08\div5.2=.4$ inch.

The horsepower is H. P. $=\frac{q\,p}{33,000}$

$$=\frac{8,000\times2.08}{33,000}=.504.$$

Ques. 13.—With a fan developing 30 horsepower at the fan, with a water gauge of 2.3 inches, but from which only 50 per cent. of useful effect is obtained, what quantity of air would be available? (M. M.)

Ans.—Thirty horsepower equal $30\times33,000=990,000$ units of work. But since only 50 per cent. of the useful effect is applied to the air, the force on the air is $990,000\times.50 = 495,000$ foot-pounds. A water gauge of 2.3 inches corresponds to a pressure of $2.3\times5.2=11.96$ pounds per square foot. Then the quantity, $q=\frac{u}{p}=\frac{495,000}{11.96}=41,388$ cubic feet per minute.

Ques. 14.—State the diameter of an upcast shaft necessary for 200,000 cubic feet of air per minute, with a velocity of 15 feet per second. (M. M.)

Ans.—The velocity of the air is $15\times60=900$ feet per minute. The area of a shaft large enough to pass this quantity of air at the given velocity in 1 minute, would be $200,000 \div 900 = 222.22$ square feet. Substituting in the formula, A (area) $=.7854\ d^2$, we have $d^2=\frac{222.2222+}{.7854}$ $=282.9414$. By extracting the square root, d = diameter of shaft $=16.82$ feet, or 16 feet 10 inches, about.

Ques. 15.—What is the horsepower of a horizontal tubular boiler 5 feet in diameter, 18 feet long, containing seventy 3-inch tubes? (H. E.)

Ans.—In boilers there is a ratio existing between the heating surface, or the surface exposed to the action of the flame and hot gases, and the horsepower developed by them. This ratio varies according to the style of boiler, but in horizontal tubular boilers may be taken as 10. That is, it requires 10 square feet of heating surface for the generation of each horsepower.

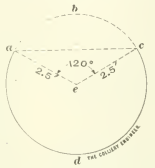


Fig. 2

The total cylindrical surface of the boiler is $18\times(3.1416\times5)=282.744$ square feet. As ordinarily hung, about two-thirds of this surface is exposed to the action of the heat. Hence, the cylindrical heating surface is $282.7440\times\frac{2}{3}=188.4960$ square feet.

The cylindrical surface of the tubes is $70\times(3.1416\times\frac{1}{4})\times18 = 989.6040$ square feet.

The calculation of the areas of the two ends of the boiler exposed to heat is rather complicated. From the area of the end of the boiler, $a\,b\,c\,d$, Fig. 2, must be subtracted the area of the circular segment, $a\,b\,c$, which represents that portion of the boiler which is *not* exposed to heat. The area of the circle, or end of the boiler is $.7854\times5^2=19.6350$ square feet. The area of the segment, $a\,b\,c$ = area of sector, $a\,b\,c\,e$ − area of triangle, $a\,c\,e$, that is, $a\,b\,c = a\,b\,c\,e - a\,c\,e$. The area of $a\,b\,c\,e$ = area of circle $a\,b\,c\,d \times \frac{\text{arc } a\,b\,c \text{ in degrees}}{360}$. Since (as stated above) two-thirds of the circumference of the boiler is exposed to heat, one-third of it is not, and one-third of a circle is 120° = arc $a\,b\,c$. Hence the area of the sector $a\,b\,c\,e$ $= 19.6350 \times \frac{120}{360} = 19.6350 \times \frac{1}{3}$ $=6.5450$ square feet. The sides $a\,e$ and $c\,e$ of the triangle are equal to the radius of the boiler, or $5\div2=2.5$ feet. The angle between these sides is 120 degrees, since it is the angle at the center measuring an arc of 120 degrees. The area of the triangle is equal to one-half the product of the sides multiplied by the sine of the included angle, or area $=(2.5\times2.5 \times \sin 120°) \div 2 = (6.25 \times .87178) \div2=2.7243$ square feet, since the sine of 120° = sine (180° − 120°) = sine 60°. The area of the segment, $a\,b\,c$ is, thence, $6.5450-2.7243=3.8207$ square feet. Further, the area of the large segment, $a\,d\,c$, which represents the portion of the end subject to heat is $19.6350-3.8207=15.8143$ square feet. As there are two ends to the boiler, the total end area exposed to heat is $2\times15.8143 = 31.6286$ square feet.

From the end areas must be deducted the areas of the 70 tubes each 3 inches $=\frac{1}{4}$ foot in diameter. These areas are $2\times70\times.7854\times(\frac{1}{4})^2=6.8723$ square feet.

The areas of the heating surfaces may be summarized as follows:

Main shell	=	189.4960 square feet.
70 tubes	=	989.6040 square feet.
Ends	=	31.6286 square feet.
Gross	=	1,210.7286 square feet.
Tube ends	=	6.8723 square feet.
Net		1,203.8563 square feet.

The total available heating surface being approximately 1,200 square feet, and since it requires 10 square feet of heating surface to yield a horsepower, the capacity of the boiler is $1,200\div10=120$ horsepower.

Ques. 16.—We have a tank full of water in the morning when we commence work; we are using 900 horsepower per hour; how long will it take to empty the tank? The tank is 10 feet in diameter and 15 feet deep. (M. M.)

Ans.—The volume of water in the tank is, V = area of base × height $= .7854\ d^2\ h = .7854 \times 10^2 \times 15$ $=1,178.10$ cubic feet. At $62\frac{1}{2}$ pounds

per cubic foot, the weight of the water is $1{,}178.10 \times 62\frac{1}{3} = 73{,}434.9$ pounds.

It is generally assumed in calculations like this, that the development of 1 horsepower will require the evaporation in the boilers of 35 pounds of water per hour. To develop 900 horsepower will require the evaporation of $900 \times 35 = 31{,}500$ pounds of water. As there is on hand 73,434.9 pounds, the tank will be emptied in $\frac{73{,}434.9}{31{,}500} = 2.33+$ hrs. $= 2$ hrs. 20 mins.

Ques. 17.—What size of bridle chain should be used on a cage when the total weight of cage and load is 15,000 pounds; using the best grade of wrought iron? (M. M.)

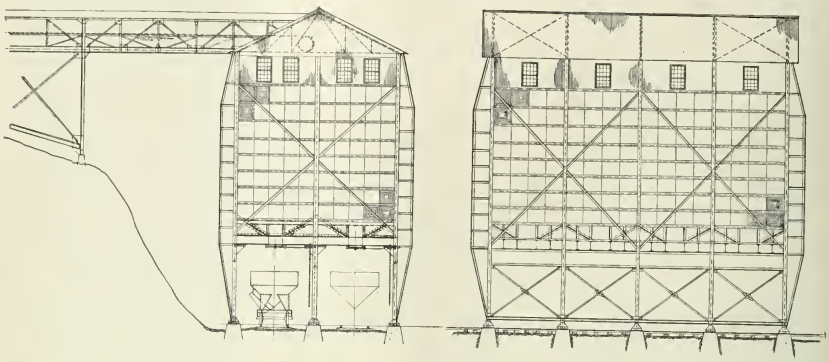
Ans.—The formula ordinarily used to determine the diameter, d, in inches of an open-link wrought-iron chain to support a given load, L, in pounds, is, $d = \sqrt{\frac{L}{12{,}000}} = \frac{\sqrt{15{,}000}}{12{,}000} = \sqrt{1.25} = 1.118$ inches. Probably $1\frac{1}{8}$ inches (1.125 inches) chain would be selected for the purpose.

Ques. 18.—What diameter of cylinder will be required to develop 50 horsepower in a non-condensing engine which has a stroke of 4 feet and makes 45 revolutions per minute, when working with a mean effective pressure of 30 pounds? (H. E.)

Ans.—The familiar formula for the horsepower, H. P. $= \frac{p\,l\,a\,n}{33{,}000}$, may be transposed to $a = \frac{33{,}000\ \text{H.P.}}{p\,l\,n}$. When the area, a, of the cylinder is found, the diameter may be calculated. In the present case, H. P. $= 50$, p = mean effective pressure $= 30$ pounds, l = length of stroke $= 4$ feet, and n = number of strokes per minute = twice the number of revolutions $= 2 \times 45 = 90$. Substituting in the formula,

$$\text{Area of cylinder} = \frac{33{,}000 \times 50}{30 \times 4 \times 90} = 152.7777+ \text{ square inches.}$$

$$\text{But } d = \sqrt{\frac{\text{area}}{.7854}} = \sqrt{\frac{152\ 7777}{.7854}} = \sqrt{194.5222} = 13.96, \text{ say, } 14 \text{ inches.}$$



Coal Bin of Allegheny Coke Co., Hellier, Ky.

Steel Slack Bin

T. J. Mitchell, of Uniontown, Pa., president of the Allegheny Coke Co., which is situated at Hellier, Pike County, Ky., has awarded the designing and detailing of a new 1,500-ton capacity slack bin to S. S. Gold and James L. Hazen, of Uniontown, Pa. This bin when completed will be one of the most modern of its kind in use in the Kentucky fields, in which Mr. Mitchell has large interests in valuable coking coal holdings. The framework of the bin will be entirely of steel and has been estimated to weigh over 110 tons. It will increase the storage capacity of the plant about three times, which will be of great value in case of accident or breakdown. Center to center of end columns is 55 feet, while the width is 30 feet and the depth of bin proper is 30 feet. One advantage of its construction is that there is no inside bracing to interfere with the flow of coal, as the columns are of girder type and are heavy enough to resist the great bending moment exerted by the coal on its natural angle of repose of 33 degrees. The girder columns are of plate and angle construction and weigh nearly 5 tons each. The main support girders are 48 inches deep and have $6'' \times 6'' \times \frac{1}{2}''$ chords with $\frac{3}{8}$-inch web.

The bin is so situated as to handle the coal with economy from two seams being mined at the same time. The difference in elevation of the two seams is approximately 170 feet, making it necessary to lower the coal from the upper seam in a retarding conveyer to a Bradford breaker, where the coal enters for the first process in its crushing treatment. From there it is conveyed to a hammer crusher, thence to a bin, where it will be equally distributed throughout the bin by a spiral conveyer. The coke plant consists of 150 ovens of the Mitchell type.—L. D. B.

NEW MINING MACHINERY

Rock Drill Operated by Gasoline Engine

The Temple-Ingersoll gasoline-air rock drill is being introduced by the Ingersoll-Rand Co. At present it is made in only one size, and the equipment employs the same kind of drill and pulsator as are used with the Temple-Ingersoll electric-air drilling outfit. The electrical equipment of the latter, however, is replaced by a 6-horsepower, single-cylinder, gasoline engine. The gasoline motor, the gasoline tank, and the pulsator, are all mounted on a four-wheeled truck to permit easy transportation. This drill is adapted to places where electric power cannot be economically or advantageously applied.

The gasoline engine is of the jump-spark type, the ignition spark being obtained from dry cells. The circulating water is supplied from any convenient receptacle placed near the equipment. The splash system of lubrication is employed for the piston and crankpin bearing, and grease cups lubricate the main bearings. A gasoline supply tank of $1\frac{1}{4}$ gallons capacity, surmounts the engine. The fuel consumption of the engine, running under load, is about 2 quarts of gasoline per hour, so that the average daily fuel consumption would be approximately 3 or 4 gallons.

The drill proper of the "gasoline-air" unit is driven by pulsations of compressed air created by a pulsator actuated by the gasoline motor. Gearing transmits the power from motor to pulsator. The air is never exhausted, but is used over and over again, playing back and forth in a closed circuit. The pulsator is a simple machine, employing no water-jackets. See Figs. 1 and 2.

The drill is the simplest kind possible. It consists of a cylinder containing a moving piston and rotation device, with no valves, chest, buffers, springs, or side rods. The cylinder is larger but the piston portion is shorter, making the weight of the drill unit about the same as, or even less than, that of the corresponding air drill. Two short lengths of hose connect pulsator and drill, each hose acting alternately as supply and exhaust.

Fig. 1. Temple-Ingersoll Gasoline-Air Pulsator and Rock Drill

Some leakage of air from the system is inevitable, and this is provided for by a compensating valve on the pulsator which is adjusted to automatically maintain the requisite pressure in the circuit.

The ordinary air- or steam-driven rock drill takes a full cylinder of air or steam at full pressure each stroke, and discharges it to the atmosphere at practically full pressure. No advantage, therefore, is taken of the expansive properties of the air or steam, and as a result an amount of power is wasted without doing useful work.

The "gasoline-air" drill operates on an entirely different principle. The closed system is filled with air under a low pressure, which is simply an agent for transmitting the effort of the pulsator piston to the drill piston. The air in the system has been aptly referred to as a pneumatic "spring," unwearing and unbreakable, exerting its pressure on opposite sides of the drill piston, and the pressure in the air is analogous to the tension of a spring. That the saving in power is great is proven by the fact that, under ordinary conditions, the drill proper of this machine uses about one-fourth the horsepower required for the usual air or steam drill, of the same capacity.

The "gasoline-air" drill has a stroke equal to, or even greater than, that of the air-driven rock drill of corresponding capacity. The length of stroke is varied simply by cranking forward in the shell, and both the stroke and the force of blow may be adjusted by the same means for fast drilling under any circumstances. If a hole should "mud up" or form a "mud collar" in bad rock, the machine can be backed out without injury while running, thus clearing itself quickly. The cushioning is such that the piston, in running, does not normally strike either front or

back head. This makes easy the problem of handling it in all kinds of drilling.

When the ordinary rock drill, whether steam or air driven, sticks or fitchers, it simply pulls back with a steady pressure and the steel must be sledged until it loosens. The "gasoline-air" drill, on the contrary, when it does momentarily stick, receives on its piston upwards of 400 alternating pulls and pushes per minute; and this repeated pulsation has a tendency to promptly loosen and dislodge the stuck bit.

The system of lubrication of the pulsator is automatic and complete, the "splash" method being employed. While most of the oil drains back to the crank chamber, a portion is atomized and carried through with the air into the drill.

The drill cylinder diameter is $4\frac{3}{4}$ inches and the stroke is 7 inches. The drill will accommodate octagon steels from 1 to $1\frac{1}{8}$ inches in diameter, drilling holes from $1\frac{1}{4}$ to 2 inches in diameter. The drill feed is 24 inches. The approximate strokes per minute are 440. The machine is designed to drill holes up to about 12 feet in depth.

This drill is economical in power consumption; easy to understand and operate, and will appeal to the small operator, because of the lower installation cost, no compressor or boiler plant being required.

Sells Roller Bearings for Mine Cars

A new roller bearing for mine cars that has possibly overcome some of the most patent obstacles that have hitherto stood in the way of the more extensive adoption of those energy conserving devices is shown in Fig. 3.

It consists of a number of large diameter rollers retained in a roller structure that is placed around the shaft, and enclosed within a high-carbon steel casing, called the "Unit Lining." A frequent objection to roller bearings, that the friction saved in using the rollers is lost in their contact with each other, producing an undesirable form of sliding friction, appears to have been overcome in the mounting of the rollers in a roller structure that keeps them constantly separated and parallel to the axle.

This form of construction is said to carry with it, three very important

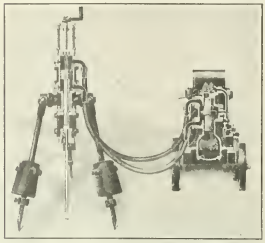


Fig. 2. Sectional View of Drill and Pulsator

advantages; smooth-running and long-lived rollers that maintain their cylindrical form until they have been worn out; an extra reduction of friction that has not been obtained in any other way; and practically permanent use of the original journal box, since the entire imposition of the load is effected through the "Unit Lining," that can be replaced quickly and cheaply.

Rugged construction to withstand the hard service and abuse of the mining regions has been amply provided in generous dimensions of parts, and suitable materials.

These bearings should have some effect on mining economics, for with the 25 per cent., or greater, reduction in bearing friction, that the manufacturer guarantees, the speed and capacity of haulage engines and

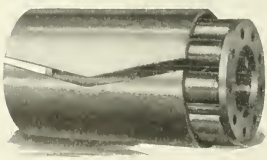


Fig. 3

locomotives can be increased; and the cost of equipping with roller bearings, to get this increased capacity, can be hardly compared with the greater cost of additional hauling facilities.

These bearings, are known to the trade as the "Sells" Commercial Type Bushing, and are manufactured by the Royersford Foundry and Machine Co., of Philadelphia, Pa., which has long been known as the maker of the "Sells" roller bearings for line shafts.

Electric Safety Lamps for the Powder Men

By H. W. Harter

If there is any place where an open-flame lamp is out of place, it is on the hats of the men who carry dynamite or powder around in the mines. This applies not only to coal mines, but to mines of all kinds where explosives are used. The practice of powder men carrying explosives on their shoulders with a lighted open-flame lamp is not nearly so rare as mine superintendents may imagine, and even if the man who carries the explosive puts out his light or carries his lamp in his free hand, the danger of sparks and snuff igniting his explosive is not entirely done away with. If he has another man walk ahead of him to light the way, the hat flame lamp may trail sparks after it. If the man who carries the explosive slips or falls, he may bring the light and the explosive together with disastrous results.

Many accidents occur every year in mines from open-flame lamps coming in contact with explosives, either dynamite, blasting powder, or blasting caps; no matter if the light is a candle or a lamp supplied by oil, paraffin, or carbide, it is dangerous to handle any kind of explosives near it. Moreover, there is no necessity for so doing, as there are several kinds of electric cap lamps on the market, which the Bureau of Mines has sanctioned for use in gaseous and dusty coal mines and which are both convenient and efficient and admirably adapted for the use of the men who handle explosives in any kind of mine. They will not ignite powder dust raised, sometimes, in the operation of pouring powder

from a keg; they will not drop hot flaming oil or grease into boxes of blasting caps. In fact, they can hardly cause an accidental explosion with dynamite or powder under any conceivable condition, and the mine owner who really has the "Safety-First" principle at heart, should seriously consider equipping his men with one of the several types of electric safety cap lamps—the only real safety lamp.

Locomotive Record at Scalp Level

Eighteen 100,000-pound capacity steel railroad cars, loaded in a single day, is the record output recently made by one motorman at mine No. 1 of the Scalp Level Coal Mining Co., whose offices are at Windber, Pa. This is one of the John Lochrie operations.

On this day they worked exactly 9 hours and 45 minutes. The only haulage equipment used was an 8-ton Baldwin-Westinghouse Barsteel electric mine locomotive, Fig. 4, equipped with commutating-pole motors. This locomotive, except for a few mine cars hauled from a dip from a point in the heading by a mule, did all the work, gathering the coal cars and hauling them to the tipple. When work was stopped in the evening, the locomotive was inspected and found to be in first-class condition, in spite of the heavy work performed. The motors were nearly as cool as when they started in the morning. The cost of operating this locomotive for the day was: motorman, $3.30 and spragger, $2.90, making in all, $6.20.

Twelve mine cars, each loaded with 2 tons of coal, were hauled on each trip. The longest haul was about 2,500 feet from the face of the first to tipple and about the same distance from face of main heading to tipple. The grades in this mine at two points for a distance of 400 feet are 1½ per cent. against the loads.

Thirty-six trips were hauled, and it is estimated that at least 2 minutes were lost on each trip on account of the motorman waiting for empty cars outside. Notwithstanding this loss of time the operators feel certain this was the highest run of coal ever made in western Pennsylvania in one day by one motorman, and it is believed that it has never been equaled elsewhere.

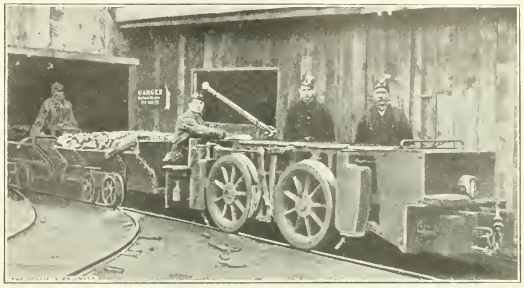


Fig. 4. Baldwin-Westinghouse Barsteel Electric Locomotive

The men at this mine claim that there was no extra effort made this day to make a record. It was only an ordinary day's work and they believe that if they would make an extra effort, this locomotive could gather and haul sufficient coal to at least load 24 steel cars.

Improved Measuring Tapes

Important improvements have recently been added to the line of tapes made by the Lufkin Rule Co., of Saginaw, Mich. These consist of a steel case-liner for leather cases and a push-button opener for winding handles which heretofore were embodied only in the very highest priced steel measuring tapes.

These improvements are now added without increase in price. "Challenge" and "Challenge Junior" steel tapes now have leather cases steel lined throughout. This gives the case extraordinary stability, also has made it possible to make it narrower than before by a full ⅛-inch, and hence neater in appearance and more compact. These cases now also have a positive action push-button opener of new design for the winding handle. "Rival" and "Rival Junior" steel tapes have nickel-plated steel case as before, but the edge or case band is knurled to afford a good firm hand hold. The cases are now also equipped with a positive action, winding handle opener.

TRADE NOTICES

The Link-Belt Co., of Chicago, recently completed the new tipple at Lowe, W. Va., for the Weyanoke Coal and Coke Co. The tipple was described in detail in the February issue of The Colliery Engineer.

DeLaval Steam Turbine Co.—Mr. S. Wolff, formerly manager of the Cleveland office of the Allis-Chalmers Manufacturing Co., has been appointed Chicago manager for the DeLaval Steam Turbine Co., manufacturers of steam turbines, centrifugal pumps, centrifugal air compressors, speed reducing gears, etc., with offices in the Peoples Gas Building.

The Roberts and Schaefer Co., of Chicago, have a contract with the Paint Creek Collieries Co., Charleston, W. Va., for a new coal-mining plant in which the "Marcus" patent picking table screen will be installed. This tipple will be built at Olcott, W. Va., at an approximate contract price of $27,000. The Harlan Coal Mining Co., of Louisville, Ky., have also ordered a coal tipple and retarding conveyer from the mine, which

plant will be built at Caxton, Ky., at a contract price of $25,000.

The 1914 Sales Convention of the American Blower Co., was held in Detroit on January 28, 29, and 30, and was attended by 50 of the company's sales and engineering representatives. The annual banquet was held at the Cadillac Hotel. Business sessions were held both at the hotel and the company's home offices. Many important and interesting subjects were discussed and decided upon. Contrary to expectations, pessimism had no place whatever during any part of the convention and everybody left having a very optimistic view for more and better business for 1914, than was booked during the previous year.

Change of Name.—Announcement is made that the Insulation Department of the Armstrong Cork Co., has been taken over and will hereafter be conducted by the Armstrong Cork and Insulation Co. The personnel of the management and the sales force will be the same as heretofore. The growing importance of the insulation business and the recent addition of a line of steam pipe and boiler coverings which contain no cork, rendered it desirable to make this change for the more satisfactory and efficient transaction of the company's business.

Safety-Lamp Lighter.—The safety-lamp igniter, originally patented in 1911, by L. D. Vaughn, mine inspector of the Third West Virginia District, is now being adopted by carbide lamp makers.

It is a very handy article when attached to carbide lamps, but its chief value is in its ability to relight safety lamps in gaseous mines without exposing the operator to danger. In the gaseous mines of the anthracite fields and in those of southern Illinois, it is not now necessary to travel and grope in the dark until a relighting station is reached, for the miner can relight his own lamp even in explosive mixtures without danger. With the simple Vaughn lighter the miner has 5,000 chances to relight his lamp, before it is worn out. The Vaughn-Miller Co., of Clarksburg, W. Va., are the manufacturers.

Electric Installation.—The Pond Creek Coal Co., Stone, Pike County, Ky., will add to the equipment of its mines, six 6-ton, 44½-inch gauge mine locomotives. The Lehigh Coal and Navigation Co., will add to the equipment of its mines at Lansford, Pa., six 15-ton and nine 8-ton electric mine locomotives; also for the No. 5 shaft at this colliery, a 750-horsepower induction motor, three 500 kv-a. transformers, control equipments, switchboards, and accessories. The Hudson Coal Co., Scranton, Pa., will install a 435 kv-a. motor-generator set and switchboard, and will place in operation in the mines three 7-ton, 30-inch gauge electric mining locomotives. The Elkhorn Fuel Co., Allen, Ky., has arranged to install six 200-kilowatt rotary converters, eighteen 65 kv-a. and nine 150 kv-a. transformers, switchboard equipment, etc. All of the above are of General Electric Co. manufacture.

Marion Shovels.—A new catalog just issued by the Marion Steam Shovel Co., of Marion, Ohio, especially describes the Marion revolving shovels and has a number of features that are of convenience to busy men: Its convenient size permits its being carried in the pocket; the way in which it opens makes it particularly convenient to hold in one hand and leaf over with the other; the different phases of excavating to which the shovels are adapted are taken up concisely; the index gives a quick method for obtaining any particular data; the table of working dimensions presents a quick and easy method for obtaining specification data on all three of the smaller revolving shovels.

New Fan.—The Robinson Ventilating Co. has installed a new mine fan at the Aultman mine, near Jacksonville, Pa. It is unusual in that it is directly connected to a General Electric brush-shifting polyphase commutating motor of variable speed.

Catalogs Received

Marion Steam Shovel Co., Marion, Ohio. Marion Revolving Shovels, 47 pages.

American Blower Co., Detroit, Mich. Sirocco System of Purifying—Cooling—Humidifying, 7 pages.

Wolf Safety Lamp Co., of America, Inc., 47-49 West St., New York, N. Y. Wolf Naphtha Safety Lamps, 40 pages; Wolf Acetylene Lamps, 24 pages.

Platt Iron Works Co., Dayton, Ohio. Triplex Power Pumps, 51 pages.

Buff & Buff, Jamaica Plain, Mass. The Buff Transit, 43 pages.

Wm. Powell Co., Cincinnati, Ohio. Powell Valves, especially the "White Star" Valve, 16 pages.

General Electric Co., Schenectady, N. Y. Electric Fans, 41 pages; Belt-Driven Alternators, Form B, 7 pages; Small Motor-Generator Sets, Types MIC and MCC, 7 pages; Small Plant Direct-Current Switchboards, 3 pages.

Laidlaw–Dunn–Gordon Co., Cincinnati, Ohio. Air Compressor Efficiency, 8 pages.

Morgan-Gardner Electric Co., Chicago, Ill., Continuous Coal Cutters, 32 pages.

Deane Steam Pump Co., 115 Broadway, N. Y. Horizontal Double-Acting Single-Cylinder Power Pumps, 16 pages.

Gardner Governor Co., Quincy, Ill. The Gardner One Tool Plant, 4 pages.

The Terry Steam Turbine Co., Hartford, Conn. Bulletin 17, Return Flow Turbine, 8 pages.

National Tube Co., Pittsburg, Pa. "National" Bulletin, No. 18A, "National" Reamed and Drifted Pipe, 12 pages.

Mesta Machine Co., Pittsburg, Pa. Bulletin "M" on Mesta Improved Pickling Machine.

Central Foundry Co., New York City. Booklet showing Universal Pipe in service.

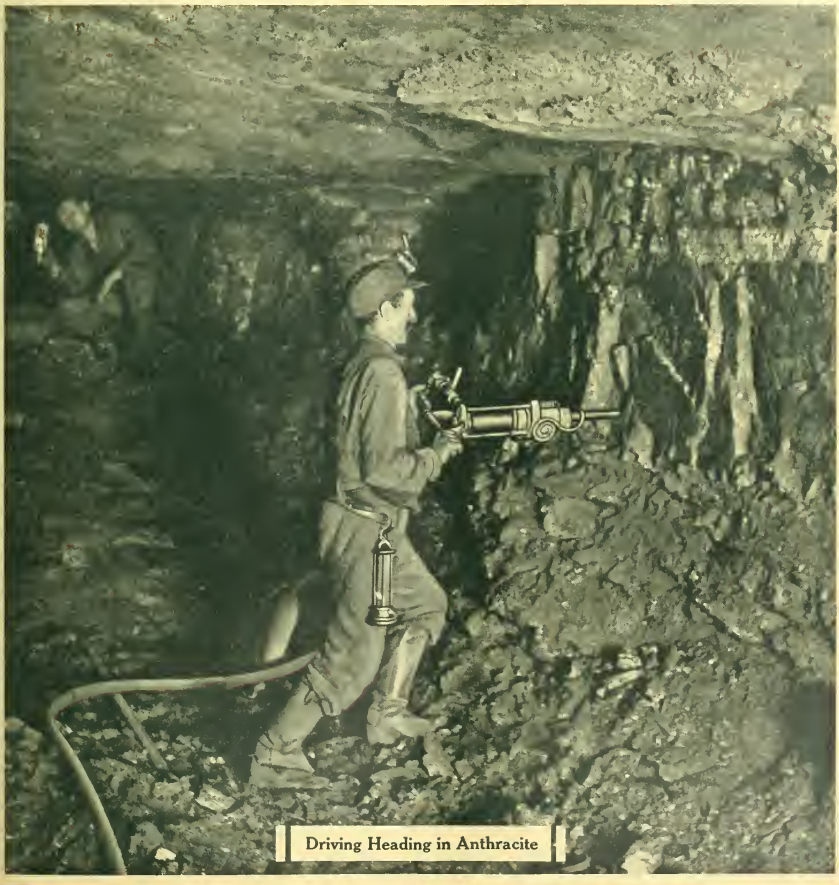
S. F. Hayward & Co., New York City. Oxygen Reviving Apparatus.

The Colliery Engineer

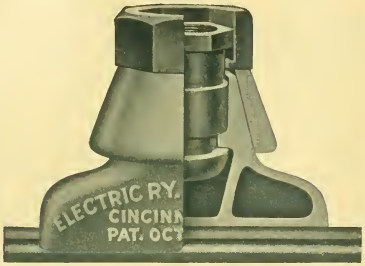
Vol. XXXIV—No. 9 APRIL, 1914 Scranton, Pa.

Alphabetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68



Driving Heading in Anthracite



"SURE GRIP"

"Sure Grip" is not simply a trade name used to designate our particular brand of Trolley Clamps.

It is also an absolute guarantee—it's a fact.

The "Sure Grip" Trolley Clamp is all its name implies.

It is so constructed that, once adjusted properly, it is simply impossible for it to work loose or to drop the wire.

This is but one of the features that have made the "Sure Grip" Trolley Clamps so popular in the mine field. Men in the workings feel absolutely secure when walking along passages where trolley wire is strung. They know that the wire **cannot** work loose and hang down, endangering their lives.

Made in all sizes from 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine & Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

INSULATED WIRES AND CABLES

FOR

Light, Power, Telephone, Telegraph
Mining Machines and Locomotives

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXIV—No. 9 APRIL, 1914 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1881

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer

RUFUS J. FOSTER, Vice-President and Managing Editor

EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor

CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second-class matter

Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE, 15,000

TABLE OF CONTENTS

Editorial—
Anthracite Conciliation Board—Visiting Coal Mines—Uniformity in State Mine Inspectors' Reports—Ohio's Foolish Mine Laws 523
Personals 525
Standard of Ventilation 526
A Brick Tipple, by Wilbur Greeley Burroughs 527
Analysis of Coke 529
British Coal Mines Act, 1911 530
Mining in Eastern Kentucky 532
Facts Concerning the Mining Industry 533
German Coal-Dust Precautions, by Bergassessor Doctor Tornow 543
Carrying the Meridian Down a Shaft 543
Treating Mine Timbers 544
Selection of Induction Motors, by C. A. Tupper 546
The 1911 Bituminous Mine Law 549
Insurance on Mine Property, by W. H. Charlton 551
"Bumps," Their Cause and Effect, by John Shanks 553
Packer No. 5 Mine Fire 554
Air-Hammer vs. Rotary Drills, by Pol Dunaime 555
The Rheolaveur Coal Washer, by Leo Dorey Ford 558
Electric Mine Lamps 559
Moistening Coal Dust, by James L. Davidson 561
Book Review 561
Columbia School of Mines 50th Anniversary 562
The Panel System in Ohio, by Wilbur Greeley Burroughs 564
Use of Naphthalene in Coal Briquets 565
Uniformity in Inspectors' Reports, by Rufus J. Foster 567
Burning Low-Grade Anthracite, by J. E. Parrish 569
The Bituminous Coal Industry and the Sherman Law, by Charles M. Moderwell 570
Coal and Coke Section of A. I. M. E. 570
Flooded Coal Mine in Illinois, by Frank Rosbottom 571
Telepathy in Rescue Work 572
Obituary—
John E. Waters—George Patterson 572
Coal Mining Comparatively Safe 572
Letter Box—
Correction—The Prevention of Accidents—Rescue Work Instruction—Stone Dusting in Dusty Coal Mines 573
Notes on Mines and Mining 575
Examinations—
Mine Managers, Mine Examiner and Hoisting Engineer, Illinois; and First-Class and Second-Class Certificates in British Columbia 576
Prize Contest 579
New Mining Machinery—
Hammer vs. Piston Rock Drills, 581—Bristol's Pneumatic Type Recording Tachometer, 582—A New Mine Car Truck, 583—Brush-Shifting Polyphase Motor, 584—Self-Rescuing Apparatus, 585—A New Coal Cutter, 585—The Coppus Turbo Blowers 586
Trade Notices 586
Catalogs Received 586
Squibs—
Depth of Oil Sand, California, 550—Pacific Coast Fuel Trade, 554—Rapid Depreciation, 558—Coal Excavation and Panama Canal, 564—Cost of Cylinder Oils, 575—World's Coal Reserve 580

Anthracite Conciliation Board

THE Anthracite Board of Conciliation came into existence in 1903, as the result of the Strike Commissioners' endeavors to bring about harmony between the miners and operators.

That the plan was eminently satisfactory is evidenced by the miners and operators signing an agreement May 20, 1912, to continue to abide by the decisions of the Board.

Since signing the last agreement there have been 100 cases brought before the Board, or three times as many as compared with the 3 years previous; besides, there have been many labor troubles and petty strikes, which have been in violation of the agreement, but which were settled by the District Mine workers' officials sending the men back to work. The Board is composed of three representatives of the operators and three representatives of the mine workers, and in case of non-agreement, former Commissioner of Labor Charles P. Neill is called in as umpire. Recently there have been many "button strikes" in order to force the non-union mine workers into the union. One of the subjects being agitated by both miners and their officials is whether the companies will permit foreign mine workers to force American citizens to join the union, irrespective of their wishes. In one of its most recent decisions, the Board of Conciliation unanimously recommended the discharge of some troublesome mine workers, employes of G. B. Markle Co., and members of the United Mine Workers of America. The mine workers had claimed the right to exclude non-union members from the mines, in violation of that clause in their agreement which provides for non-discrimination against union or non-union men.

Visiting Coal Mines

THE visiting of the interior of mines by men and women, to gratify idle curiosity, is a practice that cannot be too harshly condemned. They learn nothing from such visits, interfere with the work, and frequently run into great danger through their ignorance and unfamiliarity with mines. All they gain by such visits is an unpleasant sensation if they descend a shaft, and what to them is a novel experience in "darkness made visible." They can get the same unpleasant sensation by riding on a fast elevator from the upper floor

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

of a sky scraping building, and can see just as much by going into a damp cellar on a dark night with no other illuminant than a small candle. Both of these trips can be made safely and without ruining clothing. Mine visitors who are inspired merely with idle curiosity and a desire for a novel experience are a nuisance to mine managers, and are frequently a source of danger not only to themselves, but to the mine employes.

In the absence of any legal means to prevent mine visiting by those having no business in the mines, the mine officials should absolutely prohibit it. Such prohibition would not prevent mining engineers and other mine officials visiting mines, because they only make such visits when they have business in them, or when they desire to study peculiarities in the coal seam or other strata, or to examine the methods of mining, timbering, drainage, ventilation, haulage, etc.

As a recent instance of the danger incurred by non-mining visitors to coal mines, we quote the following news item from the Scranton *Tribune-Republican* of February 25:

Nelson Banchrost, 32 years of age, of New York City, died at the State Hospital yesterday morning at 4 o'clock, as the result of injuries sustained while making a tour of the National mine of the Lackawanna Coal Co., Monday night, with a party of friends. While walking through one of the chambers he was caught between a car and a prop and received internal injuries, which caused his death.

If the unfortunate man mentioned in this item had been familiar with mining operations, he would, in all probability, have been able to take care of himself and would have avoided being caught as he was, between a moving mine car and a prop.

Uniformity in State Mine Inspectors' Reports

AS WILL be seen, in an article on "Uniformity in State Mine Inspectors' Reports," on another page, there is practical unanimity in the opinions of the Inspectors of the various states, that uniformity in the fiscal year covered, and in statistical tables, is most desirable.

In some states, uniformity can be arrived at, as far as the most essential items are concerned, by the adoption of statistical tables on the line of some acceptable model; the mine laws of such states providing for the collection of practically similar statistics for the calendar year. In other states, the fiscal year differs from the calendar year, and the mine laws do not, in some instances, require the operators to furnish certain important statistical information. As a rule, the operators and mine managers of such states will cheerfully give the inspectors the desired information, but there are some few who will not, either from a mistaken idea that it is inimical to their interests, or because it entails a little extra clerical work which they think is unnecessary. To bring about uniformity in all states, there will, therefore, have to be some slight modifications of the mine laws. Such modifications can be easily made without changing the general tenor of the sections regulating mining generally. If the Mine Inspectors' Institute of the U. S. A., as an organization, takes the matter up, and its members individually urge such changes, there is no reason to expect anything but cooperation from the leading mine managers.

While we do not hesitate to say that some state mine laws are incomplete, and in some instances impractical and harmful, we do not believe that it will be good policy to make the matter of statistics collection and a uniform fiscal year part of a scheme to revise the entire law. If that is done, extremists will take advantage of the opportunity to insist on measures so drastic and impractical, or so loose and useless that the conservative, rational men on all sides will oppose any change.

First, secure uniformity in reports. That will be a long step forward in eventually securing practically uniform rational laws, beneficial alike to the mine owners and the mine workers.

Ohio's Foolish Mine Laws

THE state of Ohio has some new mine laws. We don't know who was primarily responsible for them. We do know what the new laws will be responsible for. They will be responsible for great loss to the state through the injury they will inflict on the coal mining industry.

Briefly stated, one of these laws prohibits "shooting off the solid" in Ohio mines. If it stopped with the prohibition it would not be a bad law. In most bituminous mines "shooting off the solid" is a dangerous and wasteful practice. But, the law permits "shooting off the solid" in certain cases, as shown by the following quotation from the law:

A permit to do solid shooting may be issued by the *Industrial Commission of Ohio* in the case of any mine when application shall be made therefor by the owner, lessee, or person engaged in the operation thereof and by a majority of the miners employed therein, and when such Industrial Commission shall be satisfied that such method of blasting is necessary for the just and reasonably profitable operation of such mine. Such permit may be revoked at any time by said Commission after 60 days' notice in writing to such owner, lessee, or person operating such mine. Any person in interest who is dissatisfied with any order of said Industrial Commission made under the power conferred upon it by this section, may commence an action to set aside, vacate, or amend such order in the same manner and for the same reason as other orders of such Commission may be set aside or vacated."

It will be noted that the Industrial Commission of Ohio is the authority which will give permission to "shoot off the solid." It will also be noted that the permission has a string to it, whereby litigation with its consequent trouble and expense can be forced on the mine owner.

For instance, in a mine where the majority of the miners are illiterate, non-English-speaking men, a trouble breeder can incite them to demand the privilege

of "shooting off the solid" on the ground that it will save the labor of undercutting, even if it does require a waste of powder, increases the amount of slack, and increases the danger. The minority of skilled miners and the mine officials may oppose "shooting off the solid." That will make no difference; the majority will want it, and they will get it. The proviso that the order permitting "shooting off the solid" may be set aside if a successful suit is waged in court, doesn't amount to anything. Mine owners and mine officials who try to make a business success of a coal mine in Ohio have neither the time nor means to be continually engaged in legal disputes.

Another law restricts the right of the mine owner and mine worker in the matter of contract. It provides that all coal mined must be paid for on a "run-of-mine" basis, and not on a screened-coal basis, as has been the practice in the past, and the Industrial Commission is the authority to determine the percentage of slate, sulphur, rock, dirt, or other impurity for which the operator must pay.

In the first place this law, aside from its injustice in restricting the right of employer and employe to enter into any contract they may see fit, is an utterly impracticable one. The amount of slack or impurities that will go out in every mine car will not only be different at every mine, but will be different in every chamber, as it will depend on natural conditions and the varying degrees of ability and honesty in miners.

It is not necessary to go into all the objections to the laws mentioned. The above brief statements show their injustice to the mine owners. If all the unjust and impracticable features of the bills, as applied to practical mining, were eliminated, there would still be a most ridiculous state of affairs.

The laws mentioned take the management of the mines, to a great extent, out of the hands of the mine owners and their trained officials and put it in the hands of an Industrial Commission composed of three men and a secretary. The gentlemen composing the commission may be men of integrity and high personal character, but that they are totally unfit to dictate how the coal mines of Ohio shall be run is shown by the following brief statements as to their professional and business experiences:

Wallace D. Yaple, chairman of the commission, is a lawyer by profession, who served a term as Mayor of Chillicothe, and whose principal business was insurance.

Prof. M. B. Hammond, vice-chairman of the commission is Associate Professor of Economics and Sociology, Ohio State University. His entire life has been devoted to the study of economics and sociology.

T. J. Duffy, the other member of the Commission, is a potter by trade, and, when appointed on the commission was at the head of the Potters' Union. He has had no experience in coal mining.

W. C. Archer, secretary of the commission, is a young man who was formerly engaged in newspaper work in a small Ohio town.

In short, a lawyer, a professor of economics and sociology, and a potter, assisted by a young newspaper man, will hereafter dictate how the coal mines of Ohio shall be operated, if they are worked.

Some of the Ohio mining companies are already taking action to conserve their capital and property and to prevent loss as much as possible. Among those that have taken precautionary steps is the Pan-American Coal Co., which closed its Granger mine, at Buckeye, and stopped all work on opening a new mine on Turkey Run, near Cannellville, which would have been the largest mine in central Ohio, would represent an investment of $114,000 and for which 14 cars of machinery are now on the ground. The Duncan Run Coal Co. has also suspended work on the opening of a mine near Cannellville which was estimated to cost $50,000.

Other projected mines are being dropped, and many going mines will undoubtedly be shut down, unless the fool actions of the Ohio General Assembly and Governor are speedily made non-effective.

Rational mine laws are necessary for the insurance of safe and economical coal mining, but mine laws suggested by politicians, farmers, and tinkers, which place the control of the mines in the hands of men entirely unfamiliar with mining conditions are disastrous.

PERSONALS

Prof. Henry Tschetschott, of the St. Petersburg Mining Institute, has registered at the Massachusetts Institute of Technology for special work. His coming is part of a general plan of the government to educate Russians, in the best places possible, for positions as teachers in the home schools. Already there are at the Institute of Technology, two other Russians, Messrs. Penn and Ortin, who have likewise been sent by the government.

T. H. O'Brien, general manager; Frank Weitzel, chief engineer, of the Stag Cañon Fuel Co.; and Rees Beddow, state coal mine inspector of New Mexico, recently made a tour of mines in Southern Colorado and examined methods in use for humidifying the mine air. They were also shown the methods of applying adobe dust, in a part of the Delagua mines, by Samuel Dean and other officials of the Victor-American Fuel Co. Mr. O'Brien is now using adobe dust in the Dawson mines.

Irving R. Gard, formerly chief mining engineer of the Canadian Collieries (Dunsmuir) Ltd., Victoria, B. C., has assumed the management of the Mecca Colliery Co. He will make his headquarters at Eagle, W. Va., where the main offices of the company are located.

G. L. Cox, of the La Follette Coal, Iron and Railway Co.'s engineering department at La Follette, Tenn.,

has accepted a position with the Solvay Process Co., at Paint Creek, W. Va.

George M. Shoemaker, formerly superintendent of the Virginia Lee Coal Co., has been appointed superintendent of the Rex No. 1 mine of the La Follette Coal, Iron and Railway Co., succeeding H. Bevan.

D. H. McGhee, superintendent of the Buck Ridge Coal Co., at Shamokin, Pa., has been appointed general manager of all the property of Irish Bros., in Pennsylvania and West Virginia.

J. H. Allport, manager of the Clinchfield Coal Corporation's operations in West Virginia, has resigned his position owing to ill health.

James B. Smith, of San Francisco, Calif., has been elected president of the Western Fuel Co., operating mines at Nanaimo, B. C., succeeding the late J. L. Howard.

W. L. Keen has been elected vice-president of the Solvay Collieries Co., vice L. P. Jones, resigned; J. C. Rawn, formerly general manager, has been appointed consulting engineer.

William Lamont, of Beaverdale, Pa., has been appointed assistant superintendent of the mines of the Pennsylvania Coal and Coke Corporation at Patton, Pa.

Frank Dunbar, superintendent for the Ellsworth collieries at Ellsworth, Pa., resigned to accept a similar position with the same company at the Wehrum plant.

V. S. Veazey has been appointed chief engineer of the McKell Coal and Coke Co., at Glen Jean, W. Va.

Richard A. Parker has been elected president of the Colorado Scientific Society for this year.

F. W. Bradley has given to the University of California, from which he graduated in 1886, the sum of $1,000 per year for 10 years, for the purpose of aiding students in the College of Mining whose records and ability seem to promise that they will be of material service in development of the mining resources of the state." Aid is to be given through loans, and repayments and interest, which is to be charged after graduation, are to be added to the original fund.

Reginald W. Brock, director of the Canadian Geological Survey, has been appointed to the position of Deputy Minister of Mines, succeeding Dr. A. P. Low, who has recently retired.

Prof. S. B. Christy is chairman of the San Francisco section of the A. I. M. E.

The University of Pennsylvania has conferred on E. V. d'Invilliers, the honorary degree of Doctor of Science. Doctor d'Invilliers graduated from the University in 1878, and has been chosen president of his class every year since that date.

R. T. Donaldson, on April 1, becomes general coal sales agent for the Jamison Coal and Coke Co., with headquarters in Pittsburg, having resigned his position in the sales department of the Pittsburg Coal Co., to take effect at that time.

L. F. Timmerman, secretary of the Davis Coal and Coke Co., announces that at a meeting of the board of directors of that company, held March 3, Alfred W. Calloway was elected president of the company, in place of J. M. Fitzgerald, resigned. Mr. Calloway, a few months ago, became general manager of the company, leaving the general superintendency of the Buffalo, Rochester, and Pittsburg Coal interests.

F. A. Dunbar, superintendent of the mines and operations of the Ellsworth Collieries Co., at Ellsworth, Pa., has been appointed superintendent of the Wehrum, Pa., plant of the Lackawanna Coal and Coke Co., vice Harry J. Meehan, resigned.

J. M. Cook, superintendent of mines of the Cambria Steel Co., has resigned his position, and been succeeded by Harry J. Meehan, of the Lackawanna Coal and Coke Co. plant at Wehrum, Pa. Mr. Meehan is one of the rising young operating officials whose abilities promise a great future.

M. D. Ratchford, Commissioner of the Illinois Coal Operators' Association, on March 4, tendered his resignation, effective April 1. No reason was assigned for the resignation.

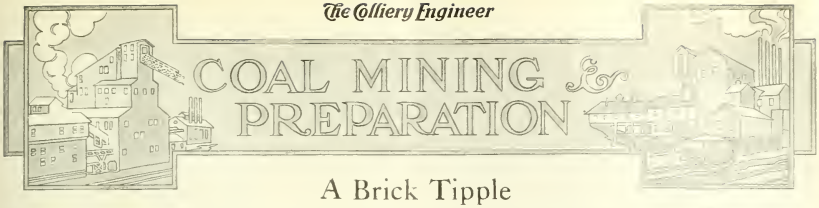
F. E. Gobey, superintendent of motive power of the Lancashire & Yorkshire Railway and allied coal interests, is in New York City, investigating American machinery.

Standard of Ventilation

In the new British mine code there is a clause which prevents the erection of ventilating furnaces underground. The new code establishes the standard of ventilation in the following terms:

"An adequate amount of ventilation shall be constantly produced in every mine, to dilute and render harmless inflammable and noxious gases to such an extent that all shafts, roads, levels, stables, and workings of the mine shall be in a fit state for working and passing therein, and, in particular, that the intake airways up to within a hundred yards from the first working place which the air enters shall be kept normally free from inflammable gas. In the case of mines required to be under the control of a manager, the quantity of air in the main current and in every split, and at the point where the haulage worked by gravity or mechanical power ends, and at such other points as may be determined by the regulations of the mine, shall at least once in every month be measured and entered in a book to be kept for the purpose at the mine. For the purpose of this section a place shall not be deemed to be in a fit state for working or passing therein if the air contains either less than 19 per cent. of oxygen or more than 1¼ per cent. of carbon dioxide."

An addition made to the clause reads: "The Secretary of State may, by order, exempt any mine or mines from the foregoing provision, on the ground that they are liable to spontaneous combustion of the coal but subject to any conditions specified in the order."



A Brick Tipple

A Novel and Economical Form of Construction for a Tipple Having a Capacity of 680 Tons per Day, in Ohio

*By Wilbur Greeley Burroughs**

A BRICK tipple, costing approximately 50 per cent. less than a similarly planned tipple constructed of steel, was erected recently at the new mine No. 22, of the Hisylvania Coal Co., in the Sunday Creek division of the Hocking Valley coal field, on the outskirts of the town of Glouster, Athens County, Ohio. Directly in front of the tipple are the tracks of the Kanawha & Michigan Railroad, over which the coal is shipped.

* Oberlin, Ohio.

The tipple stands at the base of the hills on the eastern edge of the flood plain of Sunday Creek, where, formerly, there was a swamp. The foundations for the tipple were sunk through this swamp to bed rock, 9 to 12 feet below the surface, and the swamp was filled in with material secured by cutting away a portion of the hill at the bottom of which the tipple is located.

The construction of this tipple offers some new ideas which will be found of interest, as it is probably the first brick tipple in this country.

The framework of the tipple, composed of 2-inch steel pipes, was first erected. Around the steel pipe 19-inch square brick pillars were built. As the brick pillars were built higher and higher, enclosing the steel pipes, the spaces between the bricks and the pipes were filled with concrete. The girders and floors

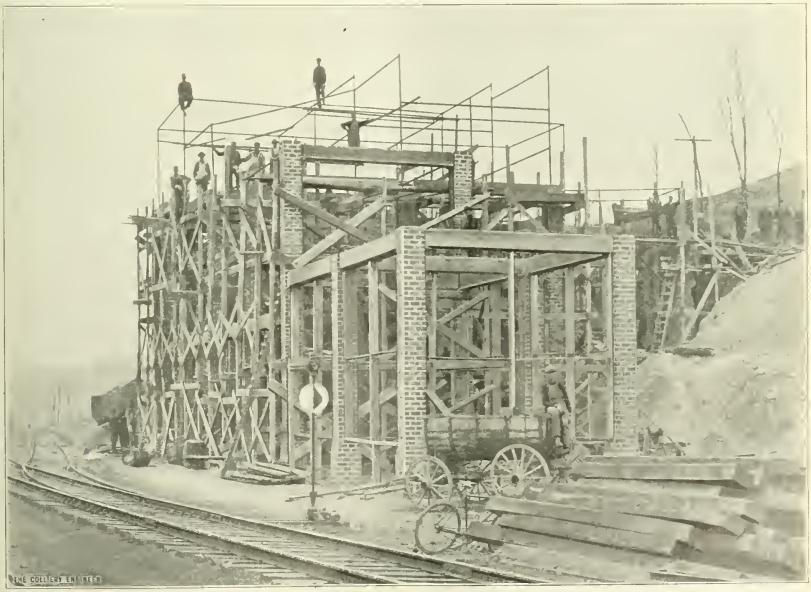


Fig. 1. Brick Tipple in Course of Construction

of the tipple are of reinforced concrete and the sides of steel.

The original plans, designed by Frank L. Ray, consulting engineer, of Columbus, Ohio, were for a concrete tipple, but Mr. Blower conceived the idea of making the composite brick tipple described.

In connection with the tipple there is a power house constructed in a similar manner that is shown in plan, Fig. 2. At present the power house contains three 350-horsepower boilers, one Westinghouse automatic compound engine, one 225-kilowatt generator with room for a 100-kilowatt generator which is about to be added. There is, in addition, a 150-horsepower engine made by the Monongahela Engine Co., for operating an endless-rope haulage system in the slope.

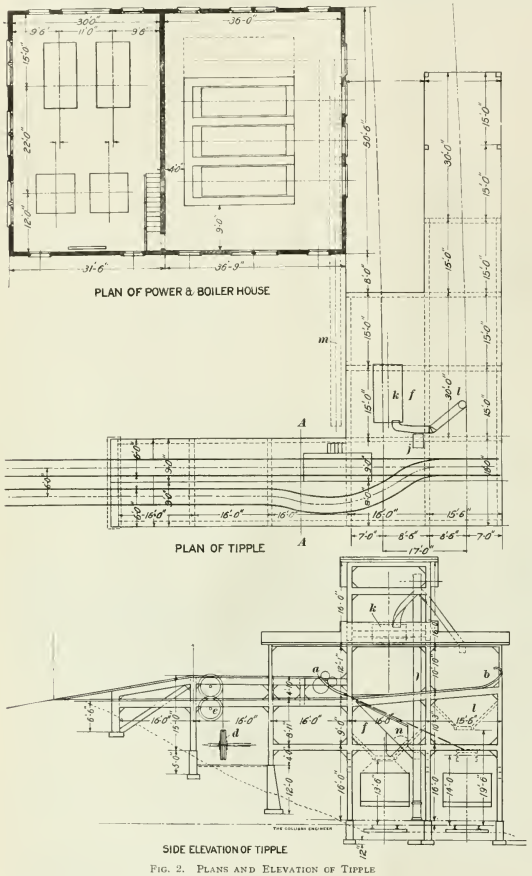


Fig. 2. Plans and Elevation of Tipple

The loaded cars are gripped by the rope and pulled up the slope to the tipple platform, where they are detached just before they reach the Jeffrey cross-over dump *a*, Fig. 2. After the coal is discharged the cars cross over to the kick-back *b*, where they stop and there run backwards by gravity to the empty-car slope track, where they are gripped to the return rope and lowered into the mine.

The rope hauling the loaded cars on to the tipple passes over a sheave wheel centered on the loaded track and then to the drum *d* from which it returns to sheave wheel *e* and thence down the slope centered on the track for empty cars. The coal on being dumped passes on to the regulation Ohio screen, with 1¼-inch spaces between the bars, which separates the lumps from the nut and slack. The finer coal goes into bin *f* while the lump coal glides on to the movable picking table *g* driven by the 3½-horsepower motor *h* shown in Fig. 3, after which it passes on to the lowering boom *i*, and is dropped into the railroad cars.

This combined picking table and lowering boom was made by the Jeffrey Manufacturing Co. The picking table is 4 feet wide and 20 feet long; the lowering boom is 28 feet in length, making a total length of the combined picking table and lowering boom of 48 feet. It is capable of handling 120 tons of run-of-mine coal per hour at a speed of 40 feet per minute. The picking table end of the equipment is horizontal, but the lowering boom is adjustable, being operated by either a hand chain, or an automatic electric hoist; in the present instance, the lowering boom is being raised and lowered by an electric hoist. Due to the picking table and lowering boom, the coal with which the railroad cars are loaded is clean, and there is little or no breakage of the coal in passing from the lowering boom into the cars.

The coal which passes through the 1¼-inch screen and falls into slack and nut bin *f*, is to be lifted

by a bucket elevator j to the shaking screen k and there separated into nut coal and coarse slack. Steel chutes will carry the two grades to their respective bins l from which they can be loaded into the cars on the lump coal track. From the nut-slack bin f, there is a chute leading to the conveyer m, which carries the coal to the boiler-house coal bins.

By reference to Fig. 2, it will be seen that there is a valve n below the nut-slack bin f, which drops the coal passing through the 1¼-inch bars to the elevator j or allows it to pass into cars under the slack bin. Once in the railroad cars, the coal is weighed on a Fairbanks railroad scale.

The tipple has been in use somewhat over 6 months, 680 tons of coal have passed over it each day, and still there is no vibration of the tipple whatsoever, and it is as firm and rigid as tipples that are constructed entirely of steel or concrete.

For the greater part of the information contained in this article, and for illustrations, the writer is indebted to J. W. Blower, president of the Hisylvania Coal Co., and to E. M. Blower, director.

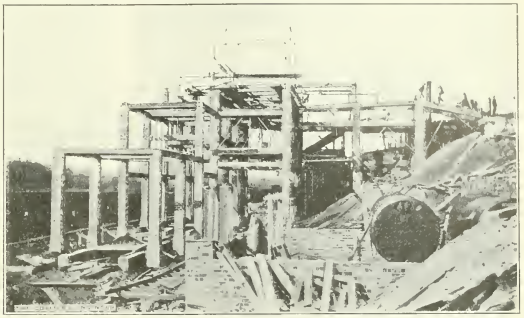


Fig. 4. Tipple and Power House in Course of Construction

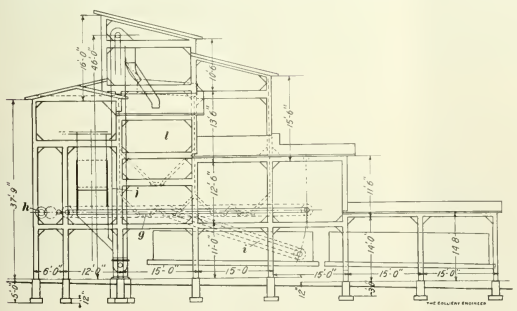


Fig. 3. Longitudinal Section of Tipple

Analysis of Coke

In the Report of Committee on Standard Methods (Transactions of American Foundrymen's Association, 1912, 143), detailed description of methods for sampling are given. To determine moisture: Dry 1 hour at 104 to 107° C. Volatile: The crucible containing the dried sample is supported inside of another, leaving about ½ inch space. Ignite 3½ minutes over a burner and 3½ minutes over a blast. Fixed carbon and ash: Burn off in the ordinary manner. Sulphur: Mix .7 gram of sample (80 mesh) with 12 grams Na_2O_2 and .5 gram powdered $KClO_3$ in Ni crucible of 40 cubic centimeters capacity. Support the crucible in a 600-cubic-centimeter beaker containing H_2O enough to immerse the lower half. Put on the cover, which has a hole in the center, through which is introduced a red-hot wire to fire the charge. After firing, dissolve in the H_2O, remove support and crucible. Add HCl to dissolve, then slight excess NH_4OH, and filter. Using methyl-orange, neutralize with HCl, and then add .5 HCl in excess. Precipitate with 10 cubic centimeters $BaCl_2$ solution added slowly to the boiling solution. Boil 15 minutes, stand 2 hours, and filter. Phosphorus: Burn 5 grams to ash. Treat with 10 cubic centimeters HCl and 20 cubic centimeters HF. Evaporate to dryness, and fuse with 1.5 grams Na_2CO_3 and 2 grams KNO_3. Dissolve, etc., precipitate with NH_4OH, dissolve in HNO_3 and precipitate with MoO_3 mixture. The acidimetric method is applied.

British Coal Mines Act, 1911

A volume has been issued by the Home Office containing the general regulations, orders and rules, made under the Coal Mines Act, 1911, which were in force on November 1, 1913, together with the Home Office memoranda as to the tests for explosives and safety lamps, and certain other matter.

The volume, which is entitled "Coal Mines Act, 1911, Regulations and Orders," is published (bound) at the price of 3s. (by post 3s. 4d.), and copies can be obtained, direct or through any bookseller, from Messrs. Wyman & Sons, Ltd., Fetter Lane, London, E. C., and 54 St. Mary St., Cardiff; H. M. Stationery Office, (Scottish Branch), 23 Forth St., Edinburgh, and Messrs. E. Ponsonby, Ltd., 116 Grafton St., Dublin.

Mining in Eastern Kentucky

What the Consolidation Coal Co. is Doing at Jenkins—A Description of the Methods of Coal Cutting Employed and the Large Central Power Station

By William Z. Price

IN THE particular section of the country herein described, a comparatively small amount of coal has been mined but the development has been almost perfected and the operating company will soon be producing coal at a rate that will challenge comparison.

In the latter part of the year 1910 the Consolidation Coal Co. purchased 100,000 acres of land in Letcher, Pike, and Floyd counties, underlaid by the Elkhorn seam averaging slightly over 8 feet in thickness, and drained by the Elkhorn Creek which flows into the Big Sandy River and the waters flowing into the North Fork of the Kentucky River. The map, Fig. 1, shows the relative location of the various mines in that vicinity.

The two towns, McRoberts and Jenkins, were named in honor of two of the directors of the company. The former town, about 6 miles west of Jenkins, is reached from the western section of the state by the Lexington & Eastern Railroad, a subsidiary of the Louisville & Nashville Railway. The Sandy Valley & Elkhorn Railroad, extending 35 miles from Jenkins to Shelby, where it connects with the Chesapeake & Ohio lines, is a part of the Baltimore & Ohio system.

The mines at Jenkins, eight in all, will cover approximately 6,500 acres when fully developed according to their projections. Similarly, 3,800 acres will be mined out by the five mines operating at McRoberts, but it is at Jenkins that the greatest developments are visible.

The topography of the country is favorable to coal mining. Though the mountains give an impression of some of the West Virginia districts, still the coal is not excessively high up on the mountainsides as is sometimes the case in that state, but high enough to easily accommodate a tipple as is shown in several of the accompanying photographs.

All the mines at the latter place are drift operations save No. 206; there a rock slope was driven down 150 feet on a 32-degree dip to the seam. At the slope bottom, the cars are fed by means of a trip feeder on to an endless-chain car haul which takes them to the tipple. After

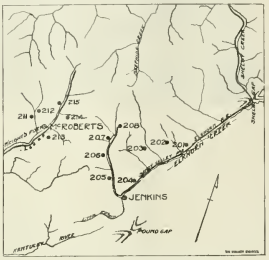


Fig. 1. Operations Near Jenkins

dumping, the cars make a loop around the hillside and enter the mine through a drift opening.

The coal in this field has the following average analysis: Moisture, 1.76; volatile matter, 34.21; fixed carbon, 60.53; ash, 3.50; sulphur, .62; phosphorus, .005; while its heat units are measured to be 14,425 British thermal units.

The seam, however, has several undesirable features, a band of shale and clay that occurs near the middle, and a soft slate roof. About 1 foot of top coal is allowed to remain to safeguard the roof. This is considered a probable loss.

The middle band of clay is entirely taken care of with the unique method of coal cutting by the Drennen-Jeffrey turret coal cutting machine. The machine was designed by the Jeffrey Manufacturing Co.'s engineers at the request and with the cooperation of Everett Drennen, the manager of the operations at Jenkins.

The band of clay and shale varies from 2 to 5 feet above the bottom of the coal and with the customary undercutting this would become so intricately mixed with the coal that clean coal would be an impossibility. The turret machine eliminates this problem by cutting out the clay first, thus enabling the coal to be shot down clean.

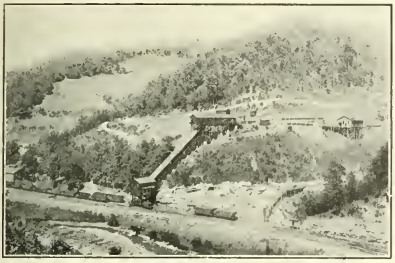
The machine, as shown in the photograph, is mounted on a turntable truck carrying four standards on which the machine is moved up and down to the required height. A disk friction clutch enables the machine runner to control the raising and lowering of the machine at the rate of about 1 foot in 5 seconds. The machine is equipped with a reel similar to that of a gathering locomotive; it is also arranged for self-propulsion and will travel about 4 miles an hour.

Frequently it has been found that by cutting out this shale seam only two small shots are required for the top and two for the bottom bench, which lessens the danger of damaging the roof and practically eliminates blown-out shots. The machine has been the means of giving a cleaner product of coal, more rapid mining at less expense per ton, and furnishes a safer method of mining coal.

The entries and rooms are driven 10 and 15 feet wide, respectively. When the machine moves into a room, an anchor hole 2⅛ inches in diameter is first drilled in the coal under the shale band and approximately in line with the left-hand track rail. An anchor is fitted into this hole, and the feed-rope attached. The machine is then turned on the turret by hand toward the right-hand rib, making an angle of about 15 degrees with the track, at which point the cutter bar is automatically locked in position. The machine is then pulled toward the face and started and the cutter bar forced into the coal to a depth of

Camp at No. 202

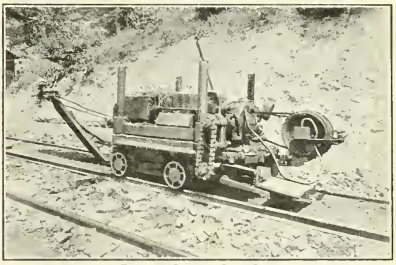
Main Street, Jenkins, Ky.



Tipple at No. 201

Tipple and Tracks Near McRoberts

Hauling Boiler Over Mountain in Kentucky



Drennen-Jeffrey Coal Cutter

Company Offices at Jenkins

Company Club House, Jenkins

about 8 feet. When the cutter bar has reached the full depth of the cut, the feed-rope is attached to an extension arm which is securely bolted to the lower part of the truck, the rope being taken around a sheave, and the end fastened to the machine proper. With this hitching, the cutter bar swings across the face, its speed being about 32½ inches per minute at its extreme end. The cut across the face is completed when the cutter bar stands at an angle of about 20 degrees to the left of the track, and it is again automatically locked. The feed-rope is then carried to the machine over proper sheave wheels, and attached to a jack-pipe set 20 to 30 feet from the face between the track and the left-hand rib. The feed is then started and both machine and truck are pulled back, cutting the left-hand rib as the machine retreats from the face. When the cutter bar is clear of the rib, it is swung into a central position over the track, the machine lowered, the self-propelling gear thrown in, and it is ready to move to the next working place.

The cutting is done in the shale at the bottom of the band with the bits cutting into the coal about ¼ inch; this causes the shale to fall in the kerf, after which it is cleaned out, loaded in cars, and hauled out of the mine. This insures clean coal.

A 15-foot place can be cut in 11 minutes from the time the machine enters the room until it is ready to leave, and 25 rooms have been cut in a shift of 10 hours.

The first machine was installed about a year ago. The company now has 26 in operation. On account of its high speed, both in cutting, adjustment, and self-propulsion, it affords economical mining and renders the work safer.

All the mines are shipping run-of mine coal, hence no tipple machinery of elaborate design is demanded.

A central power station situated at Jenkins supplies the mines with all the necessary power. The boiler-room equipment consists of six double-drum Babcock & Wilcox boilers of the Rust type, each equipped with Foster superheaters, which superheat the steam to about 400 degrees Fahrenheit. The coal for boiler fuel is dropped from railroad cars into a crusher at one side of the power house; there it is pulverized and fed into a Link-Belt bucket conveyer. This conveyer has chains hanging down in front of each boiler and by this agency the buckets can be dumped at any boiler desired, there being a chute at that point from the conveyer to the firebox where the coal is fed by Detroit mechanical stokers. The buckets after passing over the boilers, go down and return underneath, catching the ashes and dumping them at the other end of the building. Only three sets of boilers aggregating 800 horsepower are now in use.

In the power room, current is furnished by two 2,300-volt alternating-current generators directly connected to Curtis steam turbines. Excitation for the generators is furnished by two 75-kilowatt, direct-current generators, one driven by a 125-horsepower non-condensing Curtis steam turbine and the other by a 2,200-volt induction motor. All the electrical equipment is of the General Electric Co.'s design.

The generators produce an average current of 2,300 volts, which is transformed to 40,000 volts for high-tension transmission lines to the various substations, where it is reduced by step-down transformers and converted to 275 volts direct current.

The water for condensing is supplied from the lake located 400 feet southwest of the power plant. Two large Mullins pumps are used to produce a vacuum of approximately 27 inches which is steadily maintained. After leaving the condensers the water is returned to the lake by means of two centrifugal pumps driven by De Laval steam turbines. This hot water is carried about 900 feet up the lake through a submerged concrete pipe to insure cold water being returned to the condensers.

A striking feature of the company's progressive methods at Jenkins is the establishment of a forestry department. Experience in other fields has shown the detrimental effect of forest denudation, and to prevent a like situation facing the Jenkins operations the company instituted this department in July, 1911. At first the work consisted in regulating and supervising the cutting, control of all logging operations and the prevention of all waste and forest fires. Lumber operations and the utilization of damaged timber for mine ties, caps, etc. demands a great deal of attention. Estimates of the standing timber, data on growth, etc., are being secured as rapidly as possible in order to draw up a working plan for the systematic management of the whole territory.

Sociologically, the company has been equally aggressive, and Jenkins will rank with Gary, W. Va., and other similar mining towns which represent advanced ideas.

Facts Concerning the Mining Industry

The Secretary of the American Mining Congress, Mr. J. A. Calbreath, furnishes the following in regard to the mining industry:

It is second only to agriculture in national importance.

It has a production valued at two billion dollars annually.

It employs directly a million and a half men.

Another million men fabricate its products.

Its output constitutes 65 per cent. of the traffic of the railroads.

It employs 750,000 coal miners.

The yearly production of coal in the United States now aggregates more than 500,000,000 tons.

The coal production, placed on regulation railroad cars, would make a train that would reach around the world without the locomotives.

Pennsylvania employs more than 300,000 coal miners.

Pennsylvania's coal output is not much less than that of Great Britain.

German Coal-Dust Precautions

Methods Employed for the Prevention of Coal-Dust Explosions in the Mines of Germany

*By Bergassessor Doctor Tornow**

THE attempts of the German mining industry, to prevent coal-dust explosions in mines, date back several decades. As early as 1884 the firedamp commission appointed by the Prussian government to study firedamp explosions by practical trials at the Neunkirchen (Saar) experimental station, gained the fundamental knowledge that coal dust scattered in the air can explode; that it becomes very dangerous, even in deposited form, as it may be, through the force of another explosion, raised up and exploded by the accompanying flame in such a way that the explosion may extend to parts of the mine which are free from firedamp. However, this experience became valuable only after extensive explosion catastrophes proved the extreme danger of coal dust, which is, in fact, almost as dangerous as firedamp.

Few explosions, which may be attributed to coal dust alone, have occurred in Germany, thanks to the precautionary measures introduced at an early date, at least, as far as mines are concerned. In the manufacture of briquets, from the dry, loose, brown coal, rich in bitumen, explosions of dust can only be prevented by exercising the utmost care.

The largest explosions which occurred in German mines during the last few decades, are as follows:

Firedamp and coal-dust explosion at the Westfalian mine "Carolinenglück" on February 17, 1898. The death roll amounted to 110. This explosion in particular opened the eyes of the German miner to the terrible danger of dry coal dust.

Another coal-dust explosion in the "Konigin Luise" mine, near Zabrze (Upper Silesia), in 1903, where 23 men were killed, plainly proved that the presence of firedamp, in order to cause an explosion of dust is not necessary, for the coal mines in Upper Silesia are almost entirely free from firedamp. Moreover, there was no doubt that firedamp could not have caused this explosion, as the flames extended over hundreds of meters.

On January 28, 1907, 150 lives were sacrificed in a firedamp and coal-dust explosion at the "Reden" mine (District Saarbrücken). The disaster occurred after a holiday and began through a local firedamp explosion which extended to the coal dust, which was exceptionally dry because no sprinkling had been done during the holiday.

The last two explosions in Germany, those at "Radbob" and "Lothringen" mines in Westfalia, were not caused, according to the investigation instituted by the government, by coal dust, but were almost exclusively due to an explosion of firedamp. The catastrophe at the Radbob mine took place November 12, 1908, and the one at Lothringen mine August 13, 1912; 348 and 114 lives, respectively, were sacrificed.

Besides these large catastrophes, the German coal mining industry has had almost every year a series of minor explosions, which for the most part originated through the presence of coal dust. Thanks to the effective precautionary measures, which have been introduced during the course of years, the explosions did not reach large proportions, and in most cases not more than from 5 to 10 lives were lost.

The working conditions in the German mining industry are unfortunately, in the majority of cases, very favorable to the formation of coal dust. The hardness and the brittleness of the coal make blasting necessary quite frequently. When the coal is won by hand, it generally is, through rock pressure, in a condition which especially favors the formation of dust. The extremely fine coal dust produced by rock movements in clefts and fissures is very dangerous. The steep inclination of the coal seams causes considerable sliding of the coal, and this with loading forms much dust; besides this the thin seams compel the selection of a long face of the working, in order to obtain better productive results; these long faces on the pitch contribute largely toward the production of coal dust.

The above mentioned catastrophes have taught that the danger of coal dust is by far the greatest when accompanied by firedamp. For the coal region in Upper Silesia, in which hardly any firedamp explosions occur, never has had such terrific calamities, as have been witnessed in the firedamp region. That the firedamp is ignitable, has been proven beyond doubt by a series of smaller explosions.

This experience is identical with the results obtained at the experimental stations in Germany, at Neunkirchen, District Saarbrücken, in Westfalia near Gelsenkirchen and Derne, and at Beuthen, in Upper Silesia. The station at Derne, equipped with the most modern apparatus known to science, is destined to give excellent service to the German mining industry.

Interesting and important discoveries have been made at the experiment station, among which special mention may be made of the conditions under which coal-dust explosions make their appearance. The supposition that coal dust is by far more dangerous when in connection with firedamp, has proven to be correct. The most important results of the latest experiments are as follows:

The smallest quantity of coal dust which was necessary to transmit the explosion over the entire dust-covered drift, when caused by coal

*Written for The Colliery Engineer. Translated by Major Karl Kopp.

dust only and the ignition made through explosives, was ascertained at Derne to be 120 grams to every cubic meter of air. Twice as much, or 240 grams, had to be scattered around, the rest lay on the boards unburnt. Smaller quantities of dust caused ignition, but explosions very seldom took place. In these experiments the very finest bituminous coal dust, that is the most dangerous, was used. With from 400 to 500 grams of coal dust to 1 cubic meter of air, the most violent explosions were observed. Larger quantities of coal dust did not increase the effect.

It is an entirely different matter when the ignition of the coal dust is caused by a local firedamp explosion; in this case the capacity of transmission is the most effective when the firedamp combination itself contains a little coal dust. A quantity of 70 grams was sufficient in a drift free of firedamp, to transmit the explosion over the entire drift. This is an exceptionally small quantity. From this, one may draw the conclusion that large catastrophes, through the presence of firedamp and coal dust, may be caused by very small quantities of dust, such quantities as happen in ordinary practice almost everywhere. The experiments were conducted in such a manner that an exceedingly dangerous firedamp mixture of 9 per cent. was ignited in the explosion chamber. If the chamber itself contained some dust, the above mentioned quantity of 70 grams to the cubic meter in the drift free of firedamp, was then sufficient to extend the explosion without limitation. The velocity of transmission in the drift 100 meters long was 1½ seconds.

Table 1 gives time of transmission of explosion.

From this table it will be seen that with increase in coal dust the velocity increases from 6 to ⅗ second for a drift of 100 meters in length.

Finally it was ascertained how small a quantity of gelatine dynamite is sufficient to ignite coal dust. With the most favorable conditions of 1,000 grams of coal dust to 1 cubic meter of air, using the most dangerous kind of dust, the smallest quantity that could produce ignition was found to be 50 grams, but ignition took place in a few instances with 40 grams. To ignite a firedamp mixture of from 8 to 9 per cent., 5 grams of dynamite was sufficient; smaller quantities of explosives were not used in these experiments.

Table 1

Grams Dust Per Cubic Meter	Grams Dust to 1 Meter of Drift Length	Time of Transmission 100 Meters Seconds
224	570	6
240	600	5
300	750	2
350	875	1½
400	1,000	2
520	1,300	2
560	1,400	2

The results obtained at the experiment stations and the practical experience gained by the terrible catastrophes, have made it possible in Germany to take measures which seem to be appropriate in preventing large catastrophes through coal-dust explosions in the future.

The measures adopted partly through orders issued by the government mine police, and partly at many mines voluntarily, may be grouped as follows:

1. Measures to prevent the formation of dust: Limitation in the use of explosives and sprinkling the working places.

2. Measures to render harmless the coal dust accumulated. Removal of dust, and sprinkling.

3. Measures which serve to confine the explosion to the centers of its origin and to prevent its spreading to other parts of the mine by extinguishing the flames (simple and concentrated zones).

A short sketch of these measures and the results obtained in applying them follows: In connection with the last mentioned method, to which almost all nations interested in coal mining have devoted their energies, also those experiments are mentioned which have produced no practical results.

To the measures for the prevention of the coal-dust danger belong, above all, those for the prevention of firedamp; for the latter is, considering the danger of the dust, the origin of most explosions. In this group are comprised all the numerous and well-known measures, mostly enforced by orders of the mine police, as safeguarding against fire by matches, lamps, electric sparks, and blasting. Special precaution must also be taken in driving drifts in rock or coal thus far not worked, as blowers of firedamp and unexpected strong gases might make their appearance.

Measures to Prevent Formation of Coal Dust

In order to prevent dust formation, blasting, above all, must be limited. The use of black powder and similar material for blasting is forbidden in Westfalia. Blasting in the coal, especially where rock partings widen and where clay beds or faults are met in mines threatened by firedamp, is only allowed by means of safety explosives, and only under the condition that the dust which may exist may be made harmless by watering it thoroughly for at least 20 meters from the point of blasting. Exceptions to this rule may be made only by special permit issued by the supervising government mine official. As soon as an accumulation of firedamp is perceptible at the face, blasting is not only forbidden at that point, but also at all other working places on that air split which are in the same district. The blasting is done only by absolutely reliable men selected for the purpose, who are called blasting masters and who must attend to loading and discharging the shots. The tamping should also be done by them or under their supervision, and ignition must be made only by electric distance ignition or by another just as safely working distance ignition. Only so many holes must be charged and tamped as are to be discharged simultaneously. The use of time fuses in the coal when widening side headings, and at the hol-

ing of seam faults is forbidden. Through this and many other rules the blasting is controlled so far that unintended effects, and especially an ignition of firedamp, cannot easily take place. In the first place these orders have been issued to prevent any danger from firedamp; however, they indirectly prevent coal-dust explosions, through the order that at dangerous points blasting is forbidden, because it produces a great quantity of dust.

A second method which has been successfully tested, is the so-called Meissner method of watering the place of work. It purposes the extraction of the coal and at the same time to avoid the formation of dust. The place of work is thoroughly soaked by forcing water through boreholes which are driven in normal length as in blasting. This method is especially recommended for coal full of fissures which, as is well known, produces large quantities of dust. In the first place, the water renders harmless the dangerous dust in the fissures and clefts; secondly, through the soaking, the coal comes loose in such a way that it can generally be mined without blasting. However, if this nevertheless should be necessary, the falling coal will be so damp that the formation of dust is absolutely out of the question. The soaking is brought about by making the bore hole tight and forcing water into it for from 10 to 40 minutes at a pressure of from 20 to 40 atmospheres. To mine 10 cubic meters of coal a quantity of water from 40 to 150 liters (1 liter = 2.113 pints) is necessary. This method is not in general use notwithstanding the good results which were obtained through it at some of the Westfalia mines, most likely for the reason that mining coal by this method is somewhat more expensive.

RENDERING DUST HARMLESS

In spite of all the precautionary measures known in practice, the accumulation of dust in coal mines cannot be entirely prevented. The government mine police officials, by frequent inspection of the mines, see to it that a large accumulation of dust in the mines does not take place, and if it does, they cause its removal. Great care is to be taken that the pack walls remain free of dust as much as possible, as in this case the freshly accumulated dust is a new danger that can contribute a great deal to the feeding of the explosion flame. An excellent means to prevent these dangers is the well-known flushing method in which the filling consists of small-grained material, sand, wash residue, etc., and is flushed through pipes to the working place. On account of the large quantity of water necessary, this method is quite effective in reducing the dust. It serves, besides, to increase the degree of moisture in the air through which the possibility of a dust explosion is somewhat reduced. The flushing method is seldom used in Germany on account of the large expense attached to it, and is mostly used when work is done below dwellings which might be endangered through the use of ordinary dry-work method.

SPRINKLING

The sprinkling method of allaying dust is, with few exceptions, generally in force over the whole of Germany, i. e., the systematic settling of the coal dust in the mines is accomplished by sprinkling with water. Shortly after the catastrophe at the Karolinenglück mine, where 115 men were killed, mostly through the disastrous effects of coal dust, the Royal General Mine Office at Dortmund, ordered sprinkling for its district; at first only for firedamp mines (Mine police order of February 17, 1898), and a few years later for all coal mines, by an order dated December 12, 1900, which takes into consideration that coal dust alone can cause explosion without the presence of firedamp. The favorable experience which single mines had had with this method, encouraged its general adoption, notwithstanding that many mine owners were opposed to it on account of the large expense attached. In some instances the mines were compelled to install a pipe system, 50 and more kilometers (1 kilometer = .62135 of a mile) long.

The water necessary for sprinkling is generally taken from the upper loose strata which contain great quantities of it, in such a way that the solid wood cribbing is tapped by means of pipes and the water is sent from there through a pipe system of many branches to the different places of working.

The water used for sprinkling at the workings is under a pressure of about twenty or more atmospheres. The orders issued by the mine police authorities for the Dortmund mining district, dated January 1, 1911, in force today, are as follows:

"Sec. 159. In all mines a pipe system for spraying purposes must be installed and continually kept in good working order. By means of this system all the workings serving for the extraction, hoisting, descending into and ascending from the pit, ventilation, etc., must be watered in accordance with Secs. 160-163, in order to prevent the accumulation of dust and thus eliminate the danger connected with the same."

A dispensation of this rule to install a sprinkling plant for an entire mine or only a part of the mine is given when the workings are damp or free from dust, or when extraordinary circumstances of a technical kind justify such an exception. These dispensations, so far as fat coal seams are concerned, are given by the upper mine office; in all other cases by the district official.

For sprinkling, only such water may be used as will not endanger the health of the workmen.

The district official is authorized to take samples of water from the sprinkling plants and have them analyzed at the expense of the mine owners.

Sec. 160. For all exploring work, driving headings and mining for which according to Sec. 150 the installation of sprinkling plants is prescribed, the roofs, roads, tim-

bering and coal mined in all these places and their immediate neighborhood must be sufficiently watered.

All other exploration work, such as driving headings for ventilation, etc., must be watered in such a way that the dust is rendered harmless.

In single cases, the sprinkling may be dispensed with by special permit of the upper mining office, for instance when the roof in wide places has been loosened through sprinkling in such manner that there is danger from falling rock and coal.

Sec. 161. In sprinkling, care is to be taken, that between shifts those workings designated in Sec. 160, Article 2, before the descent of the crew, and those designated in Sec. 160, Article 1, before the beginning of work, must be sufficiently watered, in order to prevent danger from dry dust.

Sec. 162. The responsibility for the watering of the work, driving headings and mining, as far as 20 meters from the face of work, rests upon the ranking miner present.

As for the rest of the workings, the watering must be done by responsible parties especially appointed for the purpose. The district manager is to provide these men, called "hose masters," with a written copy of instruction. Their names, as well as the instructions given to them, are entered in a special book.

Sec. 163. The parties responsible for the sprinkling (Sec. 162, Articles 1 and 2), must immediately report to the division head miner if they are, through defects in the sprinkling plant, prevented from carrying out the instructions given them.

The head miners when descending must take care that the hose masters attend to their work and that any defects in the watering plant be rectified at once, or if this be not possible, that work in the parts effected must be immediately stopped.

The division official is authorized to take samples of dust at any time and to have them examined at the expense of the mine owners.

However, we must consider that at the high temperature which is especially predominant in the Westfalian mines, through the saturation of the air with moisture, the result of the sprinkling, the working conditions are not so favorable, yet there is no doubt that if the watering is done in the proper way, the danger threatened by the dust is in most cases eliminated. In order to properly carry out the sprinkling, it should be controlled by conscientious overseers, as the workmen do not like to set the pipe system going, on account of the loss of work caused by it, and because of the increased sultriness of the air.

When, notwithstanding water sprinkling, catastrophes continue to occur, the conclusion that this expedient is not effective, cannot be drawn. For instance, it has often been proven that the sprinkling was not carried out properly; moreover, coal mining in Germany has increased at a rate never anticipated. The quantity of coal mined has increased extraordinarily; mining has not only been extended horizontally, but it has also increased in depth, and here in the deeper shafts the dangers include not only firedamp, but also coal dust, and no one knows what catastrophes might have happened, if the mine police authorities had not enforced sprinkling at the opportune time. For several years it has not only been a law in firedamp districts of Westfalia and Saarbrücken, but also in Upper Silesia.

MEASURES FOR THE EXTINCTION OF EXPLOSIONS

The fact that even conscientious sprinkling in unison with other measures for the removal of coal dust, cannot prevent dust explosions, has caused experiments to be made in order to confine an explosion to its place of origin and to prevent its spreading. In order to accomplish this, it is necessary to extinguish the flame in the levels leading to other parts of the mine.

Simple Zones with Water.—The main idea of these experiments is to extinguish the flame through want of burning substances or through the elimination of heat by means of special elements. The most simple experiments of this kind to extinguish the flame in the so-called wet zones, i. e., wetted sections of the gallery, have been failures in practical cases. The explosion flame, it is true, will be cut shorter through the damp sections; however, it breaks through them, if the zones are not of exceptional length. The length of an effective wet zone seems to depend, at least to a certain degree, upon the extension of the ignited coal-dust zone. Padour (see Contribution to the Exploration and Prevention of Coal-dust Explosions, Teplitz-Schonau, 1910, and second contribution, same place, 1911) figures this proportion in magnitude as being 1 : .962 to 1 : 2.04. These figures agree, at least as far as the result is of any practical value, with the experience gained at the experiment gallery at Rossitz, Upper Austria, and at the French gallery at Lievin, in that such new zones (leaving entirely out of the question the difficulties of keeping them in a wet condition, and those caused by swelling rock formations), must be in practice of exceptional length, which would not permit an economical working. To give an example, the tests made at the experiment station at Rossitz showed that the necessary length of a wet zone must be 60 meters. The ignited coal-dust zone was, at the same time, not much longer.

Simple Zones with Rock Dust.—In the experiment galleries for simple zones, rock dust in pure condition as well as mixed with coal dust, was used, besides water, for extinguishing the flame. The dust was deposited in the level of the gallery. To be brief, these experiments, with dust scattered over the level, were not more favorable than those made with water. At the test at Rossitz, cement as rock dust was used. Only

with 75 per cent. cement did the mixture prove to be indifferent to the initial ignition. When pure rock dust is used, the zones must also be extended to a considerable length. As an example, 450 grams of rock dust to 1 square meter and a zone 100 meters long are necessary to extinguish an explosion in a level that is scattered with coal dust a distance of 75 meters.

Table 2

Kind of Experiment	Quantity of Hermanit	Quantity of Bituminous Coal Dust	Length of Flame at Shot in Meters								Remarks
	Kilo-grams	Grams	1	2	3	4	5	6	7	10	No. of Test
Application of Hermanit to the walls of the explosion chamber	2	1,000	.4	11.75							The length of the flame at a shot with 200 grams of gelatine dynamite and a quantity of 1,000 grams bituminous coal dust scattered around is 12 meters.
	4	1,000	.4	9.25	11.75						
	6	1,000	.4	.40	6.75	8.00	13.00				
	8	1,000	.4	.40	1.30	1.30	1.30	8	10.5		
	12	1,000	0	0	0	0	0	0	0		
Application of water to the walls of the explosion chamber	6	1,000	.4	6.75	9.25	11.75					
	8	1,000	.4	1.30	2.95	11.75					
	12	1,000	.4	1.30	6.75	6.75					

Simple Zones with Special Extinguishing Fluids.—Special extinguishing fluids, to take the place of water, have been tested. In the Neunkirchen mine, experiments were made with a fluid called "Hermanit," which does not evaporate, can bind coal dust, and absorbs heat on account of the high percentage of water it contains. The fluid consists of a hygroscopic solution of salt mash, the composition of which is a secret.

At the Neunkirchen mines, Hermanit zones were experimented with and its effect on coal-dust explosions closely observed. The Hermanit used was tested first in the explosion chamber. A surface of about 20 square meters was spread with about 12 kilograms of Hermanit. Within this Hermanit zone 1,000 grams (2 pounds) of fine fat-coal dust was stirred up; at the same time 200 grams of gelatine dynamite was ignited in an uncovered mortar. The tests were repeated, each time another 1,000 grams of dust being added in the same zone, until ignition took place; if after a number of trials an ignition could not be caused, the tests were discontinued. In a similar way tests were made with water for the sake of comparison. It was ascertained that the ignition of the coal dust was much more difficult at the application of Hermanit than with water. The results of these trials are given in Table 2.

Similar tests took place at the trial station at Gelsenkirchen. Here an explosion chamber of the same dimensions, 5 meters long and of 10 cubic meters capacity, was used for the experiments. Two liters of fine dust with 160 grams of gelatine dynamite were ignited in a steel mortar and the flame thus created was 10 meters long, therefore going 5 meters beyond the dust zone. After one sprinkling of the chamber with water at new trials, in which the old dust remained in the chamber, explosions could only twice be prevented. At the third trial the water had become ineffectual and an explosion of 8 meters of length took place. In the same way tests with Hermanit were made. In this case also one application only was used and the dust used remained in the gallery. It took thirteen trials to explode the coal dust, and further trials caused additional explosions. Herefrom it is to be concluded, that Hermanit only became ineffectual after the settling of a large quantity of dust, for after the experiments the dust remained in the gallery.

The results obtained by the use of Hermanit in simple zones were less favorable at the Rossitz testing station, where the flames penetrated through the Hermanit zone, as the Hermanit used could not bind the dust which settled on the Hermanit application.

It is doubtful, as may be seen from these contradicting tests, whether a definite decision as to the merits of this substance can be given. At these experiments only simple zones were considered, in which it seems to be difficult to prevent coal-dust explosions, and this difficulty may not be overcome even by applications which are much more effectual than water. The use of Hermanit in simple zones would, under the circumstances mentioned, not be appropriate, even if the effect upon the rock of the application of water is not to be feared. Notwithstanding the larger effectiveness of the substance, the necessary zones will have to be too long. Furthermore, it is doubtful whether the advantage of Hermanit not evaporating is not lost if covered by such dangerous dust as that produced at the Rossitz mine. It would be a very difficult matter to find long zones free of dust, in which the Hermanit application would not be covered soon with a layer of dust. In the appliances to be described later means are pointed out where an application of Hermanit is by far more effective than in the single wet zones.

Nozzle System.—Another system for the prevention of coal-dust explosions is the spray nozzle system by which water is sprayed in certain parts of the workings in such a manner that the air-current that penetrates through the haze, is saturated with aqueous vapor, a part of which is deposited in the workings as moisture, but which even then decreases the possibility of an explosion. By this system, very fine particles of water are carried away by the air-current and deposited in the workings; thus a wet zone is formed beyond the water sprays and it was thought possible an explosion might be extinguished by spray. This nozzle system has been tried repeatedly in mines as well as at experiment stations. In the mines the water haze could only be tried as far as its effectiveness in spreading dampness is concerned. The different opinions given do not seem to

agree; however, the experiments made at the Camphausen mine, Saarbrücken district, have established the fact that, if a wet zone has really been created by the air-current, the velocity of which must be considerably increased for this purpose, the length of this zone is limited to a few meters only. In the main, it is created through the water particles that are carried along mechanically, and the distance it is carried is naturally limited. It has been pointed out that such short zones are of little value.

At these nozzle experiments the air could not be fully saturated. That one cannot create wet zones through dampness of the air without troublesome means, is established by the fact that the air, in circulating through the gallery, gradually becomes warm, which increases its capacity for carrying water. The experiments at Rossitz show that a high degree of dampness of the air somewhat diminishes the possibility of an explosion; but apparently this reduction is not so effective that in itself it could guarantee a certain security. In fact, this has been verified by experiments made by means of the nozzle system in experimental stations. Above all, it was proven that at the moment of the explosion the water spray in the air cannot prevent large explosions.

Other experiments were made at Rossitz, with veil sprays and conical sprays, which were, however, only effective at small explosions. Water veils, from 10 to 15 meters distant from the explosion chamber, cut off the flames at small explosions, (length of flame not exceeding 24 meters) at larger explosions (length of flame to 135 meters) the water veils effected a shortening of the flame to 30 meters. For example, the flame passed through the surface veil or spray of 60 liters of water a minute to an area of 2.2 square meters and a wet zone 20 meters long, and, in addition, beyond the length of the coal-dust zone, into which the water zone had been inserted.

The unfavorable effect of the water upon the rock is also noticeable when using the nozzle system, and probably more so than in the simple zone system.

The method just described should not be confounded with the use of the nozzle method when the parts of the gallery are constantly changing; this method is in use at several Rhenish-Westfalian mines. In this case the spray nozzles are attached to the water supply pipe at distances of 100 meters and are put in action periodically for some time. This method may be classified under spraying and is supposed to render harmless the deposited dust in mines that are especially dusty. Such an increased spraying should be recommended as exceedingly useful.

Concentrated Zones.—The tests with the simple zone system, with water as well as with rock dust and Hermanit, and with the water nozzle system, have shown that the fault of the method, leaving aside practical difficulties, lies especially in the limited concentration. In the simple zone system the length of the effectual zone, in order to be able to prevent also large explosions, must be made so extensive, that in practice this system does not appear to be very effective. The nozzle system has, as far as it should produce wet zones, been rather a failure in practical results. However, its effectiveness might come up to expectations through increase of the quantity of water to be sprayed; the increase would have to be in such a measure that for each zone quite extensive plants would have to be installed. The quantity of water sprayed exceedingly fine in the air, at the moment of the explosion, seldom amounts to more than two liters, as repeated experiments have shown; this corresponds with a water consumption of 60 or more liters a minute. At experiments which will be described later, an extinguishing fluid of more than 100 liters at the moment of the explosion proved to be effective; therefore, if the nozzle system be applied, tremendous quantities of water would have to be used, which is practically out of the question, on account of the rock conditions, the elaborate watering plant and the difficulties in descending and ascending.

These disadvantages are avoided through the disposition of extinguishing fluids in concentrated zones. Taffanel has adopted a new course in the prevention of coal-dust explosions, based on his experiences at the trial station at Lievin. He accumulated large quantities of extinguishing material at certain points of the explosion course and used the shock of detonation which immediately precedes the explosion, to turn this material into such a fine dust, that the passing flame either strikes a new extinguishing zone, or that it mixes with the finely pulverized dust and, as the result, is extinguished. In addition, the expansion power of the explosion is weakened by a certain throttle action. As is easily discernible, this method has the advantage over all others in that it has at its disposal, at the instant of the explosion, considerably more extinguishing material than in zones in which the quantity of the material, spread over the gallery walls or scattered in the air at the critical moment, is very limited. It is understood that Taffanel's experiments are known. They resulted in almost every instance in extinguishing even extensive explosions of from 100 to 150 meters in length either by application of rock dust or water. Even in cases where the flame penetrated through the zone, it did not seem to be effective enough to continue the explosion.

The experiments with concentrated zones have heretofore been made principally at the trial stations of Lievin, Altofts, and Rossitz. Unfortunately, the German galleries have been too short, in order to be able to undertake experiments of this kind.

After it had been proven that rock dust, as well as fluids, was able to check explosions in concentrated

zones, the question is to be decided which one of the two methods is the more practical. The rock-dust zone system is not extensively used in Germany at the present time. Even the alleged favorable results obtained with the rock dust at the Altofts trial station in England have not been encouraging enough in Germany to make further tests, not to mention its practical application in the mines. Though it is proven that the application of accumulated rock dust can check explosions, the results of these experiments do not show that rock dust is more effective than water. One point in rock dust application is especially to be considered, i. e., that the air condition is not improved at the great velocity (in Westfalian mines the velocity of the air-current is, according to Sec. 128 of the mine police ordinance, limited to 6 meters a second). Modern hygiene, based on thousands of experiments, teaches the dangers of the dust; even dust of soft slate is injurious to the lungs, not to mention quartziferous rock. And it must be remembered that if it becomes imperative to stifle an explosion in a mine, a considerable quantity of rock dust will be necessary. This was conclusively proven by the experiments at the trial stations. If the large quantities of dust which cannot be avoided in coal mines is artificially increased by rock dust, the health of the miner is evidently endangered. Statistics will probably show that the productive power and the age of the workman is reduced by the use of rock dust. These would be social consequences which forbid the application of such methods, as long as there are other means at least equivalent, and probably more effective, in order to localize coal-dust explosions; i. e., fluids which can be applied in such a way that they neither cause a change for the worse of atmospheric conditions, nor difficulties through rock swelling. Furthermore, the expense in applying the rock-dust method must not be overlooked. The costs of production and distribution of the dust and the removal of dust that has been rendered useless by too strong a mixture with coal dust, are rather high, taking into consideration the extension which such concentrated rock-dust zones would have in large mines.

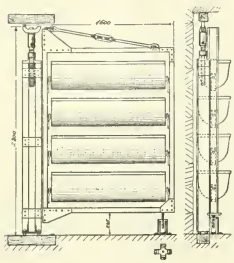


Fig. 1

Padour proposes (second contribution to the Exploration and Prevention of Coal-dust Explosions, Teplitz-Schönau, 1911), with reference to the experiments made by Taffanel, and on the strength of theoretical observations, to combine water and rock dust in concentrated zones. He figures the necessary quantity of extinguishing substance, for a mine of 50,000 square meters extension, at 2,100 kilograms of water and in addition, 1,000 kilograms of rock dust. But practical experiments with this combination have not resulted in any more favorable results than those with water alone. Moreover, it appears doubtful whether or not the quantity specified would be sufficient for an entire mine.

It seems, to judge from results thus far obtained, that the use of fluids alone is much more serviceable for the extinction of explosions. Older experiments, like the application of water to the roof or the workings of the gallery, similar to the application of rock dust, are, of course, generally known. A new very appropriate arrangement of the fluid reservoirs was invented by Kruskopf, Dortmund-Cörne. He constructed a fire extinguisher and had it patented after various experiments; the apparatus took the form as given in Fig. 1.

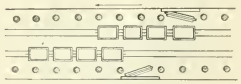


Fig. 2

The receptacles containing the extinguishing material are arranged in an iron frame which corresponds with the slope (Querschnitt), as is indicated in the drawing. The frame is suspended similar to an air door on hinges from a strut beam and is rotatory; it is propped against the face of work so that the shock of the explosion slams the door. In accordance with this idea, these receptacles are distributed along the entire roadway. In most cases it is surmised that the first shock will strike against the obstruction with such vehemence that the receptacles are wrecked and their contents scattered as very fine dust in the air. This contention was proven to be correct, as experiments subsequently described will show. The apparatus is provided with a safety attachment, which will prevent a self-acting overturning of the receptacles, while the door frame is in rotation; this takes place shortly before the frame obstructs the road. The receptacles are arranged so that a simple checking device secures them against unnecessary overturning, but in case of danger the impact is so strong, that the checking device is broken.

For a single-tracked roadway the single-winged apparatus shown in Fig. 1 is sufficient, while for a two-tracked roadway an apparatus must be placed on each side as shown in plan in Fig. 2.

So far as known, experiments with the extinguisher were made only at Rossitz and at the trial station of the Miners Mutual Association at Derne. Very favorable results were obtained with the apparatus at Rossitz. On account of the long gallery, the experiments could

be made on a large scale. A short description of the rather interesting results is given subjoined.

The Austrian gallery, with its arrangement, has been described in the

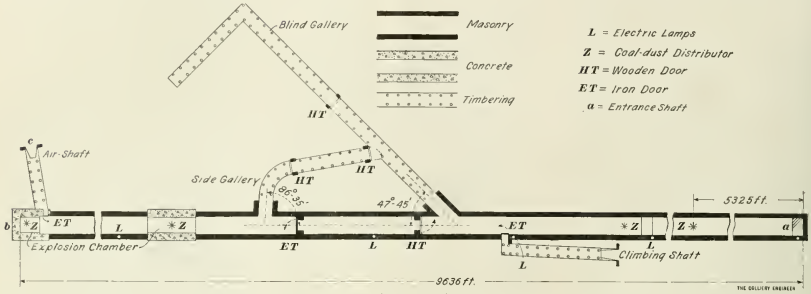


Fig. 3. Trial Gallery at Babitz, Austria

first reports about "Experiments with Coal Dust at the Trial Station of the Coal District Rossitz" (see "Osterreichische Zeitschrift für Berg- und Hüttenwesen, 1909); however, in consideration of the changes that have been made lately, a brief preliminary explanation is necessary.

The trial gallery at Rossitz was started in 1908 by the Standing Committee for the Investigation of Firedamp Questions, at Vienna. For the trials, an old main gallery, built partly of stones and partly of brick, at Babitz near Segenottes was selected; there were both solid and loose rock formation. The opening and part of the gallery were walled up, which left a trial gallery of 293.7 meters in length, the horizontal plan of which is shown in Fig. 3.

As can be seen from the drawing, the gallery has three entrances, i. e., at the lowest part of a shaft cut upwards, only a few meters high—the opening is damaged and walled up—a climbing shaft, and an air-shaft. The two last-named entrances can be closed at the workings by iron doors. A side gallery and a connecting blind gallery allow the observation of the explosive effects, both at separation and at checking of the first shock of explosive gases. The gallery has two explosive chambers which are both used in these experiments. The coal dust is inserted through a bore hole from the surface and is scattered from there by means of a flywheel turned by a shaft, as shown in Fig. 4.

In the same way there are three more dust distributors *Z* placed in other parts of the gallery, in order to supply these also with scattered dust. The main quantity of the dust is used in deposited form. For this purpose racks covered with dust, which have a form similar to window shutters, are placed against the workings at short intervals. Through this arrangement the first impact of the explosion strikes the dust and scatters it. As it is scarcely practical in an underground gallery to arrange for stations from

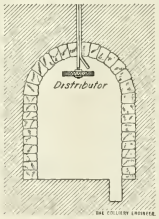


Fig. 4. Dust Distributors

which explosions may be observed, the extension of the flame is followed by means of sulphur matches which are ignitable at a rather low temperature and which are placed in wooden blocks at a distance of about 1 meter from each other. The burning of these matches will almost accurately indicate the extension of the flame, as their temperature of ignition is far below that of coal dust.

During these experiments the extension of the explosions were observed with and without the application of the explosion extinguisher.

Even if the conditions on which these experiments were based, have not always been the same, the deviations were rather important. Kruskopf apparatuses were built into the gallery, a distance of 91 meters from the explosion chamber, i. e., very close behind the next to the last dust distributor, either one, or two behind each other, within a distance of from 1 to 2 meters. The apparatuses contained, respectively, 140 or 280 liters of water or extinguishing fluid. They were built of wood and had four troughs each. That part of the gallery leading to the apparatuses, was covered with dust, by having recourse to the racks already mentioned. From 20 to 25 kilograms was deposited in this way, while through the distributor, 3 kilograms additional were scattered in the gallery and the chambers. Thus, an additional coal-dust zone was created by the last distributor 120 meters behind the apparatus. The dust used in these experiments was of the most dangerous kind; it was so fine that in a sieve of 3,480 meshes to

the square centimeter, only from 5 to 8 per cent., in a few cases from 16 to 26 per cent. of residue remained.

Ignition was introduced through gas explosions in the first chamber and through pure explosives in the second. For this purpose the first chamber was screened with paper and for want of a natural firedamp, which is only found in small quantities at Rossitz, acetylene was used, which was produced overground in a room next to the air-shaft. In most cases 100 liters of the gas were introduced into the chamber. Ignition was caused by dynamite cartridges suspended free in the air; from 350 to 500 grams of coal dust was generally used in each chamber (for date of these experiments compare "Czaplinski and Jicinsky's experiments with coal dust at the trial station of the coal mine district Rossitz," Ostereichische Zeitschrift für Berg- und Hüttenwesen, 1912).

At the Rossitz station six trials were made, three with Hermanit and three with water. The results were the same, i. e., the flame could not reach the dust zone created by the last dust distributor (at 120 meters) which otherwise would always be ignited. In accordance with the respective quantities of extinguishing fluid used, this latter amounted to 47.70 and 93 liters to the square meter of roadway. The apparatuses were completely demolished by the first shock of the explosion and the fragments hurled a distance of from 60 to 90 meters. At a quantity of 47 liters the flame was shortened considerably. At quantities of 70 and 93 liters the flame was cut off close behind the apparatus, while the flame without the latter would spread from 70 to 90 meters beyond the point designated for the stand of the apparatus, and this is due especially through the ignition of the farthest end of the coal-dust zone. Besides, through the demolishing of the apparatus, wet zones were created at the gallery walls, which extended to about 70 meters. These zones may be able to check slight after-explosions and the burning of the timber, particularly because they are quite fresh. Table 3 gives a detailed description of the experiments.

Experiments were also made for the examination of wet zones created by the fire extinguishers, following an explosion. At three of these Hermanit was used, at the other two, water. It was found that if the explosions encountered an equal quantity of dust, the effect of the extinguishers was, as could not be expected otherwise, considering previous experiences, rather insignificant. Only in one case was the flame checked. Nevertheless, the wet zones newly created by the destruction of the apparatus give considerable security against timber fires and after-explosions, the power of which, however, will not always be as great as that of the first explosion, while at these experiments explosions of equal power were tested.

Similar good results are reported lately with the fire extinguisher from the trial station at Derne. Hermanit was used.

In the gallery 100 meters long, a coal-dust zone was created extend-

Table 3

No. of Experiment	Quantity of Gas in Chamber I in Liters	Ignition Quantity of Dynamite I		Quantity of Coal Dust	Extinguisher	Fluid	Length of Created Wet Zone Behind Apparatus Meters	Distance Fragments of Apparatus Were Hurled Meters	Flame Cut Off at — Meters from Extinguisher
		Chamber							
		1	2						
611		450	400	25 kilograms on racks for 91 meters; 3 kilograms scattered in each of two chambers	1 extinguisher with 140 liters, =47 liters per square meter	Hermanit	50	60	30
					Same	Same	Wet 25 Damp 60		
618		400	400	25 kilograms on racks for 91 meters; 3 kilograms scattered in each of two rooms and 3 kilograms at 120 meters	1 extinguisher with 140 liters, =47 liters per square meter	Water	30	Entire apparatus intact, including lowest trough	6
623	400	350	400	20 kilograms on racks for 60 meters; 2 kilograms in first chamber, and 3 each at 47, 90, and 120 meters	2 extinguishers at distances of 1.5 meters, with 140 liters each, =94 liters per square meter	Hermanit	60	30	6
628	200	300	400	20 kilograms on racks for 90 meters; 2 kilograms in the first chamber, 3 in the second, and 3 each at 90 and 120 meters	2 extinguishers at distances of 1.5 meters, with 140 liters each, =95 liters per square meter	Water	70	90	3
645	400	500 Black powder	500	20 kilograms on racks for 85 meters; 2 kilograms in the first chamber, 3 in the second, and 3 each at 90 and 120 meters	1 extinguisher with 210 liters, =70 liters per square meter	Water	45	30	7

ing from the explosion chamber to 2 meters from the mouth, which without the use of the extinguisher produced at the explosion a flame 10 meters high which spread 40 meters beyond the end of the gallery. After the extinguisher was installed 51 meters from the explosion chamber, experiment was repeated under the same circumstances. The flame was put out by the extinguisher about 5 meters behind the latter, i. e., at 56 meters. Special mention is given to the fact that the wet zone created by scattering Hermanit at the workings, not only extended about 35 meters toward the open end of the gallery, but also in the opposite direction about 25 meters, a circumstance which could only have been caused by a rebound. The Hermanit, mixed with coal dust, adhered to the workings, as was the case at Rossitz, and formed through it a new wet zone of about 60 meters in length. The results of these experiments can mainly be traced back to the high concentration of the extinguishing substance in the extinguisher which, at the moment of the explosion, obstructed the entire gallery. As may be concluded from the description, the tests with Hermanit showed favorable results. For these last experiments an improved mixture of Hermanit was used, the consistence of which was of a thinner fluid than the one used in simple zones. This allowed the substance to be scattered in finer atoms. The Hermanit formerly used in simple zones represented a saponified hygroscopic lixivium; the other in connection with the extinguisher is produced by an addition of raw starch to the hygroscopic lye.

As an extinguishing fluid in comparison with water, Hermanit is undoubtedly to be preferred, since it forms, after being scattered, a wet zone from 50 to 75 meters which offers a much more effective protection against after-explosions and timber fires than water, which evaporates after a few minutes. Moreover, for this reason its storage in the receptacles is less difficult, because refilling will become necessary only after long intervals. The disadvantage that it is easily covered with dust, which may happen in simple zones, is not to be reckoned with here; on the contrary, the Hermanit is very well protected against dust in the receptacles and will thus be effective for a long time against after-explosions, as the results in the above described experiments at Neunkirchen have shown.

Compared with such an extinguishing fluid, the use of rock dust in concentrated zones has a disadvantage, because the dust may cake, which necessitates at least frequent inspections. On the other hand, the application of water offers no practical difficulties if, as is proposed in a Kruskopf circular, the uppermost receptacle constantly receives a small supply of water from the sprinkling plant; the lower receptacles will get their supply by the overflow from the upper ones. The water supply is thus easily regulated, because the evaporation will be balanced by the constant influx of water.

The level is not flooded with so much water as to cause a swelling of the rock formation which often happens with the simple zone and nozzle systems. An overflow of water in the level may be drained off by a separate conduit, in order that the place where the apparatus stands may not be endangered.

If the apparatus is properly constructed and installed, no practical difficulties in the proper working of the movable receptacles and the replacing of the water are to be feared. Furthermore, it is hardly possible that the filled apparatus will not functionate, because the impact of a dangerous explosion is so tremendous that it is absolutely certain to strike it, provided it is favorably placed and properly taken care of. By placing the axis in a slanting position, the work of the first impact will be greatly facilitated.

Compared with the French idea, i. e., that the receptacles containing the extinguishing substances be suspended from the roof of the gallery, in the same direction as the latter and following each other in short intervals, the extinguisher has the advantage of being more accessible and easily watched; moreover, the continual filling of the receptacles is accomplished better through the overflow. As a whole, the extinguisher appears to be more effective since its contents are equally distributed from the start over the entire entry.

From these d i s c u s s i o n s, however, it should not prematurely be concluded that the apparatuses in their present form and dimensions (they are built for a capacity of 500 kilograms of extinguishing fluid) will be able to withstand all explosions which may occur in practice; so far it can only be said that the experiments in their extensions hitherto p r e v a i l i n g have given throughout favorable results, and that the course pursued is promising further success. A connection of several apparatuses behind each other will, no doubt, be necessary for practical cases, for the length of the flame and its duration will, notwithstanding the cooling of the workings, which, as has been proven, has an exceedingly favorable effect at explosions, be longer in the long levels underground and at a widely extended explosion, than at the trial stations, even if the latter should have been built out to considerable lengths.

These apparatuses have already been installed in a number of Westfalian mines.

Another kind of concentrated water zones deserves mentioning here, which to my knowledge has not been tried out in German experiment stations, but which is being used as an experiment in a few German mines. In this method, invented and patented by Mining Engineer R. Cremer, in Leeds, peat and peat mull (Torfmull) are applied. This substance is fastened in the workings by means of wire netting and can absorb a sixfold or seven-

fold quantity of water. Practical experiments have not yet proven that the water thus absorbed could be utilized for the extinction of an explosion.

A governmental investigation of the catastrophes in the Radbob mines, 1903, and the Lothringen mines, 1912, had the following result: coal dust was not the main factor in the extension of these explosions; therefore, they must have been caused principally by pure firedamp. If firedamp explosions of such extensions and intensity are to be feared as initial explosions in mines, they seem to differ from the explosions in the trial station, which in comparison, are small. It would, therefore, be desirable to test the effects of explosions in a larger space, and the velocity and duration of the flame should also be ascertained. The effect of the above described extinguisher will largely depend on its extension in size, which can be adapted more easily to actual circumstances than the one in simple zones. It is also very probable that the extinguishers will, to a certain extent, check firedamp explosions, for the conditions are similar to those of coal-dust explosions. It would likewise be desirable that the apparatuses at the trial stations be tested as to their effects on pure firedamp explosions.

The effectiveness of the apparatuses will be the greater, the nearer the workings they are located. Furthermore, the establishment of extensive fire extinguishing devices for cutting off the gas zones should be considered.

At these experiments with the extinguisher the effect of crooked and blind galleries may be tried, in a similar manner as these are being used for the safeguard of magazines containing explosives, with the only difference that in this case hauling, descending and ascending, and ventilation, must be considered. Also in this direction far-reaching problems have to be solved by the experiment stations. It has already been proven that the effect of the explosion is by far smaller when it takes place in a closed gallery.

None of these methods just discussed will, however, alone be effective enough to avert coal-dust explosions absolutely. Only through the cooperation of all precautionary measures known to science will large catastrophes be prevented.

Carrying the Meridian Down a Shaft

The work of connecting the surface survey with the survey of the workings in a shaft mine is an operation that is usually a very tedious

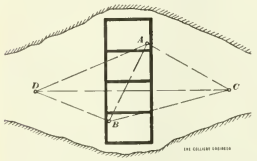


Fig. 1

and slow piece of work, and one that requires extreme care to insure accuracy.

The necessary short distance between the points from which plumb-lines are hung, makes it essential that the course and distance of that line must be measured with extreme accuracy, as it is really the base line of what are often extensive underground surveys.

Naturally, if the course and distance of the short line are calculated by the solution of a triangle of which it forms one side, and the other two sides are comparatively long, the greatest accuracy will be obtained.

A convenient, rapid and accurate method of carrying a survey underground is as follows:

Let *A* and *B*, Fig. 1, represent the two wires on plummet lines hanging in the shaft. From some convenient station of the outside survey, a course and distance are taken to each. This gives two sides and an included angle of a triangle and from these factors and the other two angles and the length of the other side, (the line between the plumb-lines) can be readily calculated and its azimuth or quadrant course determined.

After this has been done, any arbitrary station as *C* or *D*, Fig. 1, can be established in the mine. Then by setting the transit so that the vernier plates and the needle of the compass correspond, in other words, setting the instrument on the magnetic meridian, the courses and distances *CA* and *CB* or *DA* and *DB* can be measured. A similar solution of the triangles to that made on the surface will give the course of the line *AB* based on the magnetic meridian. This will differ somewhat from the true course, but the true course of the lines *CA* and *CB* or *DA* and *DB* can be determined by adding to or subtracting from the approximate courses the difference between the true course of *AB* and the calculated approximate course. The courses of the other two lines of the triangle can then be adjusted in the same way. The work can be checked by using both stations *C* and *D*, and calculating the triangles *CAB; DAB; DAC;* and *DBC*, or any two of them.

Treating Mine Timbers

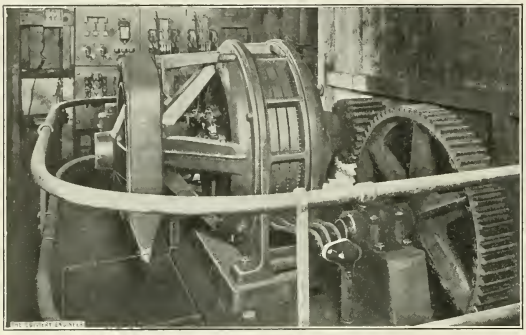
It has been known for a long time that when timbers were impregnated with strong solutions of common salt, sulphate of zinc, or sulphate of copper, they would last longer than untreated wood in dry situations. In using such timbers in mines, however, the moisture would dissolve the salts and prevent their lasting qualities Those United States Foresters who have been examining the effects of the Great Salt Lake, Utah, on timbers, offer the suggestion that ties and poles which have been immersed for some time in the waters of the lake ought to be impervious to decay if the salt is not leached out by the action of the elements. It has been suggested that this can be guarded against, for example, by painting the butt of the pole with a coat of creosote which will keep out the moisture and keep in the salt.

Selection of Induction Motors

Increasing Use of Alternating-Current Motors for Mining Work Rendered Possible by Improvements

*By C. A. Tupper**

IT IS only within the past few years that alternating-current motors for use in and around coal mines, tipples, breakers, etc. have been developed to the point where their satisfactory and economical operation could be depended upon. Now, however, motors of this class are rapidly coming into general service; and it is the object of this article to explain some of the considerations which should guide users in the selection of machines, at minimum expense, and also how to obtain the best possible results from them when installed. In this article what is said applies equally to all motors of the standards mentioned.



Induction Motor Operating Breaker Car Haul

In the matter of "phase," the purchaser is usually limited by the kind of generating plant. For coal mining work and most surface operations single phase is not ordinarily desirable. For applications requiring 10 horsepower or less, however, single-phase motors can be used advantageously and have the advantage of simple wiring. Between two-phase and three-phase motors there is little difference in cost, and they have practically the same reliability in operation. The three-phase motor, however, is becoming practically the standard for coal mining service, chiefly because of more simple wiring. The two-phase motor requires four wires brought from the source of supply, as against three for the three phase, and this slightly increases the cost of installation.

Originally the voltage was determined by the source of supply; but, as static transformers are now generally used, any desired voltage can be obtained. If a high voltage is used for the supply, by which is meant 2,200–2,300 volts or over, it is desirable that motors of, say, 250 horsepower and upward be wound for that voltage and connected directly to the line. Great care should, however, be exercised in the installation and operation of high voltage motors, and they ought to be well protected from moisture, which is injurious to the insulation. *In very damp places the lower voltages are preferable, and most mining companies are using only these underground.*

The frequency for which the motor is designed is also dependent on the source of supply. Twenty-five and 60 cycles are the most common and may be considered standard, although other frequencies are sometimes employed. On circuits supplied over long transmission lines, 25 cycles is generally used, and it was formerly considered desirable for large, slow-speed motors; 60-cycle motors of that class are, however, now made with almost equally good operating characteristics. The cost of transformers for 25 cycles is considerably greater than for 60 cycles, and the latter is considered best for general mine purposes, as the ordinary induction motors used can be secured in greater range of speeds at this frequency. Surface arc lamps are also more successful on 60-cycle circuits, but incandescent lamps in mines or mills can be operated on either frequency.

In the choice of alternating current motors, it has been found that the "squirrel-cage" induction motor, meets the great majority of requirements. This is usually of the open style, which practically corresponds to the semi-inclosed direct-current motor so far as mechanical protection is concerned. The squirrel-cage motor is so little affected by dust and the moving parts are of such rugged construction that it will operate successfully in most of the locations where an inclosed direct-current motor is required. Ordinarily, induction motors are not inclosed, but when one is to be used in a very damp location or such a precaution is desired for any reason, tight covers can be provided for the openings in the motor frame. This will, however, decrease considerably the capacity of the motor, except where it is used for intermittent service, and the selection should therefore be made with that fact in mind. To avoid the condition mentioned, when inclosing seems to be necessary, an induction motor has been developed that is fitted with covers, but also has fan-shaped projections on the rotor which draw in air through suitable ventilating holes. Motors designed primarily for coal mining service, are effectively protected by waterproof insulation. An example

*Cleveland, Ohio.

of the efficacy of this will be cited farther along.

The speeds available with alternating-current motors are somewhat limited, but a high-speed motor should ordinarily be cheaper than a low-speed machine. When the frequency is 60 cycles per second, or 7,200 alternations per minute, speeds of 3,600, 1,800, 1,200, 900, 720, 600, or 514 revolutions per minute can be obtained at no load, although few motors are designed for the first named. The full-load speed is seldom more than 10 per cent. below the no load. With 25 cycles these speeds are reduced in the ratio of 25 to 60.

The alternating-current motor is perfect in regard to reversal of rotation, it runs equally well in either direction without any adjustment or increase in cost, and the external controlling apparatus required for reversing is simple and inexpensive. The squirrel-cage motor is, however, essentially a constant-speed machine, and speed regulation is unattainable with economy.

In offering an induction motor the manufacturer will usually guarantee certain values for "efficiency," "power factor," "slip," "starting torque," and "pull-out torque," the last two being expressed in terms of "full-load torque." The clearance, or air gap, may also be given in some cases. Temperature rise is always guaranteed, in the same manner as for direct-current motors.

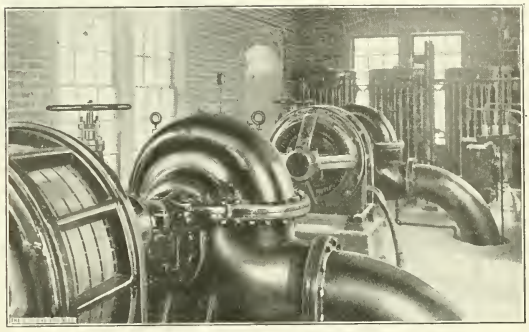
The importance of variations in efficiency depends entirely upon the amount of power that will be saved and its value. If a motor is to operate 10 or 24 hours per day, and power is expensive, a small difference in efficiency is worth considering; but in case the motor is only intended to operate for fractional periods, or if power is very cheap, the efficiency cannot be regarded as of any great importance.

The power factor is generally of less consequence than the efficiency, except where current can be purchased from an outside source of supply on the basis of a specified power factor. A motor of low power factor may have the same efficiency as one of the higher, in which case the former will draw the larger amount of current from the line, although it consumes no more power than the latter. This will have the effect of increasing the losses in the line and in the generator. In the case of a large motor or of a group of small ones on a long transmission line, however, the power factor may assume great importance. In this case the loss caused by idle current in the line and in the generator may be quite large, and the maintenance of high power factor worth considering; or the higher current to be carried might require a larger generator or heavier conductors for the line, which would very materially increase the cost. It should be remembered that an alternating-current generator is rated at an output of a given number of amperes and that low power factor indicates that some of this current is idle or useless; consequently, the generator can deliver more power, with a correspondingly greater load on the prime mover, at a high power factor than at a low. The same generator would be capable, say, of delivering 800 horsepower at 80 per cent., 900 horsepower at 90 per cent., or 1,000 horsepower at 100 per cent. power factor. The regulation of the generating plant is also better when operating on high power factor than on low.

As the power factor of induction motors decreases quite rapidly with diminishing load, and as few motors run continuously on full load, the power factor at reduced loads should also be taken into consideration.

The starting torque is not so important when the motor starts under light load, which is usually the case; but there are numerous exceptions, such as driving elevators, conveyers, car hauls, crushers, heavily loaded picking tables, slush dredger and scraper lines, hoists, etc., for which a strong pull is required to start or resume operations. "Torque," strictly speaking, is turning effort, and is usually stated in pounds at 1 foot radius from the center of the shaft, or the pull in pounds exerted at the face of a pulley 2 feet in diameter.

The "pull-out torque," expressed as a multiple of full-load torque, is the maximum that the motor can exert while running; and is somewhat more than the momentary overload that the motor has been designed to safely carry. When the pull-out torque is exceeded, the motor will stop quite suddenly and cannot start again until the load is reduced to the value of the starting torque, which is considerably lower than the pull-out. Although the motor will heat very rapidly under a load approaching the value of pull-out torque, it is well, for some applications, to have this value as high as possible, in order that



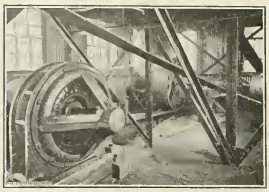
Two 100-Horsepower Induction Motors Driving Centrifugal Pumps

the motor may not be brought to a standstill by the momentary application of a heavy load, such as might be occasioned by throwing in a clutch, shifting a belt or the temporary overloading of a driven machine. From two to three times the full-load torque is commonly specified for pull-out torque.

The heating of an induction motor is the only limitation of its load carrying capacity up to the time that the pull-out value is reached. It can usually operate on heavy overload for a very brief period, depending upon the size of the motor, but the odor and smoke of overheated insulating material gives warning that a burnout is imminent. Lower loads can be carried for a longer period; most motors are guaranteed able to stand 25 per cent. overload continuously without excessive heating. Such an overload capacity ought to be included in the specifications. When operated continuously on full load, no part of the motor should reach a temperature of more than 40° centigrade above the surrounding air; and if a motor is to operate in an abnormally warm location, the limit of temperature rise should be reduced accordingly.

The "slip," usually expressed as a percentage of the full-load speed, is the amount of reduction from no-load speed that is found when the motor is operating under full load. Like the slip of a belt, it indicates direct loss of power. A motor may run at 85 per cent. efficiency on full-load while the slip is 5 per cent. If by a change in the winding the slip is increased to 10 per cent., the full-load efficiency will be reduced to 80 per cent. As the slip is approximately proportional to the load, the loss on lighter loads will not be so marked. As a rule, the slip varies between 3 per cent. and 10 per cent. For ordinary service, therefore, the motor may be considered to run at approximately constant speed.

In spite of the loss in efficiency, a motor with comparatively high slip is desirable for driving certain classes of machinery, such as those provided with flywheels or having a reciprocating motion of heavy, slow moving parts. The variation of speed with load will allow the flywheel to fulfil its function or the motion of the machine to be reversed without subjecting the motor to a heavy overload and causing violent fluctuations in the line current and voltage. In some cases it may even prevent the pull-out torque being exceeded. An increase in slip is obtained by providing the rotating part of the motor with a winding of higher resistance than would otherwise be used; which, as previously stated, also increases the starting torque. A resemblance will be noted between the induction motor with high slip and the compound-wound direct-current motor. The latter, however, does not suffer the loss in efficiency mentioned.



125 Horsepower Induction Motor Driving Conveyor and Shaking Screens in Tipple

When an exceedingly heavy starting torque is desired, when the motor is frequently started and stopped under a moderate torque and heavy fluctuations of current are caused thereby, or when a comparatively slow rate of acceleration is desired or speed regulation is to be obtained by an operator in constant attendance, the squirrel-cage winding on the rotating part of the motor is customarily replaced by an open winding, the ends of which are led to collector rings on the shaft. These rings are connected by brushes and suitable leads to a controller, the operation of which introduces a variable amount of resistance into the circuit formed between the collector rings. Such a machine is known as a "wound-rotor" induction motor. The resistance can be varied at the will of the operator; and it is possible, therefore, to carry this to a far higher value in starting than would be safe if it were left permanently in circuit. Although the speed of the motor may in this way be reduced to any desired extent, its operation at low speeds will be correspondingly inefficient, the slip indicating direct loss of power. At half speed and full-load torque the motor would show less than 50 per cent. efficiency. Furthermore, as the slip is nearly proportional to the load or torque, a motor that is running under load at very slow speed will quickly run up to very nearly the rated speed when the load is thrown off, unless the operator puts additional resistance into the circuit. Conversely, a motor operating under light load at slow speed will be brought to a standstill when the load is increased unless resistance is cut out.

The 1911 Bituminous Mining Law

Note.—At various times we have published articles in which the 1911 Bituminous Mining Law of Pennsylvania has been analyzed in such a way as to show especially wherein the new law adds to the cost of producing coal. No attempt has been made to dwell either upon the merits or objectionable features of the law as enacted, the comparisons being based exclusively upon economic features. A continuation of the analysis follows:

Article XI

Special Rules for the Installation of Electricity

If the writer were to enumerate all the details in which the new law will make operating of mines more expensive than did the old law, it would be necessary to quote page after page of the new law, for the law of 1893 contained but one sentence pertaining to the use of electricity in mines, that sentence reading, in full, as follows: "In all mines or parts of mines worked with locked safety lamps, the use of electric wires and electric currents is positively prohibited, unless said wires and machinery and all other mechanical devices attached thereto and connected therewith are constructed and protected in such a

manner as to secure freedom from the emission of sparks or flame therefrom into the atmosphere of the mine."

Only the most radical provisions of the 1911 law will, therefore, be quoted. (Italicized words do not appear as such in the law, but are used by the writer for the purpose of calling special attention to certain requirements.)

Section One
General

"2. For work underground, when supplied with current at a voltage higher than medium voltage (above 650 volts), no transformer shall have a normal capacity of less than five kilowatts, nor shall a motor have a normal capacity of less than fifteen brake horsepower." This prohibits the use of small induction motors of less than 15-horsepower at a voltage above 650 volts.

"6. In gaseous mines, high voltage transmission cables shall be installed in the *intake* airways only, and high voltage motors and transformers shall be installed only in suitable chambers ventilated by *intake air which has not passed through or by a gaseous district*."

"8. All underground systems of distribution that are completely insulated from earth shall be equipped with properly installed ground detectors, of suitable design. The condition of such system as indicated by the ground detector shall be noted each day by the person in charge of the underground wiring * * *."

"12. At *every* mine where electricity is used below ground, for power, there shall be employed a *competent mine electrician* * * *."

Section Two
Underground Stations and Transformer Rooms

"22. Transformer rooms shall be of fireproof construction."

Section Three
Transmission Circuits and Conductors

"29. * * * Medium or low-pressure conductors may be bare, *except in gaseous portions of mines no bare conductors shall be used in rooms, or beyond the last cut-through in intake entries.*"

"33. *In any gaseous mine, or gaseous portions of a mine, the electrical supply shall be brought underground only through such portions of the mine as are ventilated by intake air.*"

"38. In underground roads the trolley wires shall be installed as far to one side of the passageway as practicable, and securely supported upon hangers, efficiently insulated, and placed at such intervals that the sag between points of support shall not exceed 3 inches. The sag between points of support can exceed 3 inches if the height of the trolley wire above the rail is 5 feet or more and does not touch the roof when the trolley passes under."

"39. *All other wires*, except telephone, shot firing, and signal wires, shall be on the same side of the road as the trolley wire."

"40. *At all landings and partings where men are required to regularly work or pass under trolley or other bare power wires, which are placed less than 6½ feet above top of rail, a suitable protection shall be provided.* This protection may consist of channeling the roof, placing boards along the wire, which shall extend below it, or the use of other approved devices that afford protection."

"41. All branch trolley lines shall be fitted with an automatic trolley switch or section insulator and line switch, or some other device, that will allow the current to be shut off from such branch headings."

"42. * * * *On main haulage roads, both rails shall be bonded and cross-bonds shall be placed at points not to exceed 200 feet apart.*"

"43. Where wires for electric incandescent lamps are connected to the trolley circuit, the lug of the trolley hanger to which connection is made, *shall be drilled to receive the lighting wire, and provided with a setscrew for securing same in place. Lighting wires shall not be wrapped or tied about the stems or studs of trolley hangers.*" (A very common practice.)

"57. *In the event of a trailing cable* (of a mining machine) *in service breaking down, or becoming damaged in any way, or of its inflicting a shock upon any person, it shall be at once put out of service.* The faulty cable shall not again be used until it has been repaired and tested by a properly authorized person." The writer doubts whether any coal operator will or can comply strictly with these requirements.

"59. In gaseous portions of mines, a fixed terminal box shall be provided at the points where trailing cables are attached to the power supply * * *." The nature of the terminals is described at considerable length, and their installation will entail no small expense.

Section Five
Motors

"66. * * * and every stationary underground motor of 100 brake horsepower, or over, shall be provided with a suitable meter to indicate the load on the machine."

"67. *In any gaseous portion of a mine, all motors, unless placed in such rooms as are separately ventilated with intake air*, shall have their current carrying parts, also their starters, terminals, and connections, completely enclosed in explosion-proof enclosures made of non-inflammable material * * *."

"68. Motors used for operating fans in non-gaseous mines, where they are so situated that they are not under constant supervision of a competent man, shall be totally enclosed (not necessarily explosion-proof), unless placed in a chamber or passageway completely lined with incombustible material, and the chamber or passageway itself free from combustible material."

Section Six
Electric Locomotives

"77. Electric haulage by locomotives operated from a trolley wire is not permissible in any gaseous portions of mines, *except upon the intake air, fresh from the outside.*"

"78. In no case shall the potential used in the trolley system be higher than medium voltage" (650 volts).

"79. *Storage battery locomotives shall be used in gaseous mines only when the boxes containing the cells and all electrical parts are enclosed in flame- and explosion-proof casings.*"

SECTION SEVEN

ELECTRIC LIGHTING

"82. In all mines, the sockets of fixed incandescent lamps shall be of the so-called 'weather-proof' type, the exterior of which shall be entirely non-metallic * * *."

"83. In any gaseous portion of a mine, except where ventilated by fresh intake air, incandescent lamps shall be protected by gas-tight fittings of strong glass, except that lamps of 220 volts, or higher, and of not more than eight candlepower and without tips, need not be so protected."

SECTION NINE

ELECTRIC SIGNALING

"101. It is *recommended* that telephonic communication be established between the outside of the mine and the principal points of operation underground."

ARTICLE XIII

AMBULANCES AND STRETCHERS, RESCUE APPLIANCES, AND EMERGENCY HOSPITALS

"SEC. 1. The operator or the superintendent of every mine, in which fifty or more persons are employed inside, shall provide * * * one ambulance and at least two stretchers * * *." This is modified by a proviso making an ambulance unnecessary if ninety per centum of the workmen live within one mile of the principal entrance, and admitting of several adjoining mines having an ambulance in common. The old law required only that stretchers and blankets be kept on hand. Section 2 of the same article explains in detail how the ambulance shall be constructed and equipped. It further states:

"At all mines there shall be provided bandages, splints, and other medical supplies, to render first aid and relief to employes who may be injured. These supplies shall be kept in a suitable room. The room shall be located near the entrance to or inside of the mine, and shall be sufficiently large to accommodate the injured employes while they are receiving temporary medical attention." These requirements are considerably more than those enumerated in the old law and are worthy of commendation.

ARTICLE XV

INSIDE STABLES

"SEC. 1. * * * *If excavated in the coal seam, the walls shall be built of brick, stone, or concrete, not less than 12 inches in thickness, and said walls shall be built from the bottom slate to the roof* * * *." The old law permitted the use of wood for walls if it was "surrounded by or encased by some incombustible material," and permitted the construction of a stable merely excavated in the coal seam without any fireproofing. The construction of an underground stable in compliance with the requirements of the new law, entails very considerable expense. The new law requires that hay and straw "shall be kept in a storehouse *built apart* from the stable and in the *same manner as the stable*." Under the old law, it was necessary to have "a storehouse excavated in the solid strata or built of masonry." It was neither necessary to build it apart from the stable, nor to have it of fireproof construction with walls of at least 12 inches in thickness.

ARTICLE XVI

REGULATIONS FOR POWDER AND DETONATORS

"SEC. 2. In such portions of dry and dusty mines wherein explosive gas is being generated in quantities sufficient to be detected by an approved safety lamp, no explosives shall be used except 'permissible' explosives, as designated by the Federal Bureau of Mines. Each charge shall consist of only one kind of explosive * * *." This is entirely new and has in many districts caused serious friction between operators and employes, especially where men are paid on the screened coal basis.

ARTICLE XVII

REGULATIONS FOR OIL

"SEC. 1. * * * Not more than one barrel of lubricating oil shall be permitted in any mine at any one time and *it shall be kept in a fireproof building, cut out of solid rock, or made of masonry or concrete of sufficient thickness to insure safety in case of fire.* The old law did not require any special building for the storing of the barrel of oil. Section 2 contains a new requirement, allowing the storing of as much as 5 gallons of explosive oil in the mine, but only when stored in a masonry or concrete vault. Sections 3, 4, and 5 contain new requirements which illuminants must comply with to admit of their use in mines.

ARTICLE XVIII

EMPLOYMENT OF BOYS AND FEMALES

In this article the minimum age limit of boys working outside the mines was raised from 12 years to 14 while that of boys working underground was raised from 14 to 15. A later law, however, has raised the minimum age to 16 years for all boys employed in or about the mines. Not only have these provisions been a hardship upon many families having boys of workable size but not of legal age, but in many instances it has been necessary for operators to hire men to perform duties which boys could perform equally well at considerably less expense.

The 1911 Pennsylvania Legislature also enacted a separate law requiring the fireproofing of inside buildings, compliance with which is in many instances the cause of considerable expense. The principal requirements of this special act are: "That within 6 months after the approval of this act (June 15, 1911) *all buildings inside of any coal mine in Pennsylvania*, including engine houses, pump houses, stables, etc., shall be constructed of incombustible material, approved in writing by the Chief of the Department of Mines * * *. Any company failing to comply with this act shall be subject to a penalty of $500 * * *. Any superintendent of a coal mine failing to comply with this act shall be deemed guilty of a misdemeanor, and upon conviction shall be sentenced to pay a fine of $100, or undergo imprisonment in the county jail for a period of 10 days, or both, at the discretion of the court * * *."

Some of the provisions criticized in this article are good engineering and good common sense and can be carried out as cheaply as the old.

Insurance on Mine Property

Determining the Insurable Value of Mine Buildings and Equipment—Reducing the Cost of Insurance Without Impairing Your Protection

By W. H. Charlton*

THE amount of insurance carried on mine property can be reduced by systematically determining the insurable value of the various buildings and their equipment.

A large majority of mining companies place insurance on their property according to the cost of the buildings and the equipment contained therein, as shown by the accounts on their ledgers.

The amount of insurance carried by mining companies that have been following this method can be reduced without in any way impairing their protection, by a proper method of determining the insurable value of their property and placing their insurance accordingly.

In order to determine the insurable value of buildings and their equipment, an adequate system of cost accounting is necessary.

The accounting method outlined serves to determine the insurable value of the property and also to furnish those in authority with detailed costs, to compare with other work of a like nature.

In the case of operating companies that have passed the construction stage, the working over of the detailed charges against the various construction accounts, even if only an approximate subdivision can be arrived at, will fully repay the expense involved if it will reduce the insurance in accordance with the information obtained.

To accomplish the results desired, it is advisable to carry, preferably in a side ledger, a separate account with each (except dwellings) building, the equipment of each building, dams, trestles, railroads, etc.

These construction accounts naturally resolve themselves into three subdivisions: Buildings, equipment, and surface works.

The following subdivisions of accounts for construction work will be found desirable, and can be changed to meet varying conditions and the individual ideas of the management.

Buildings.—1, excavation; 2, grading and filling; 3, foundations; 4, superstructure; 5, electric wiring and fixtures; 6, heating plant; 7, bathroom fixtures, lavatories, etc.; 8, painting inside and out; 9, barn and outhouses.

Compressor Equipment.—1, foundations; 2, compressor cost; 3, receiver cost; 4, supplies; 5, installation.

Electric Plant Equipment.—1, foundations; 2, generating outfit cost; 3, installation; 4, switchboard cost; 5, installation; 6, transmission lines; 7, telephones and telephone lines; 8, transformers; 9, miscellaneous.

Hoisting Equipment.—1, foundations; 2, hoist cost; 3, supplies; 4, installation; 5, pulley stands, sheaves, erection; 6, ropes.

Pumping Plant.—1, foundations; 2, pump cost; 3, condenser cost; 4, supplies; 5, installation; 6, miscellaneous.

Rockhouse Equipment.—1, crushers cost; 2, power hammer cost; 3, installation; 4, motor or engine cost; 5, power transmission; 6, installation; 7, miscellaneous.

Shop Equipment.—1, foundations; 2, power tools cost; 3, motor or engine cost; 4, power transmission; 5, installation; 6, miscellaneous.

Steam Plant Equipment.—1, foundations; 2, boilers cost; 3, breeching cost; 4, feed-pumps; 5, feedwater heater; 6, installation itemized; 7, economizer; 8, stack complete; 9, miscellaneous.

Pipe Lines.—1, excavation; 2, pipe and fittings; 3, installation; 4, pipe covering complete; 5, filling in.

Dams.—1, excavation; 2, forms, etc.; 3, concrete work; 4, filling; 5, miscellaneous.

Railroads.—1, grading and filling; 2, bridges and culverts; 3, rails, fastenings, and ties; 4, miscellaneous.

Trestles.—1, excavation; 2, piling; 3, structure; 4, floor; 5, miscellaneous.

Portable Machinery and Equipment. 1, rock drills; 2, pumps; 3, tram cars; 4, skips; 5, portable boilers; 6, portable hoists; 7, diamond drills; 8, derricks; 9, sinking buckets; 10, live stock; 11, wagons, sleighs, buggies, etc.

In making detailed charges for labor and supplies, it is necessary to specify the job or account to which the items are chargeable, and the subdivision of that job or account which is benefited.

Following out this idea with the construction of a compressor house, in the "Record of Supplies Used" for the month, under the heading "Compressor House Construction," will be found all charges for supplies against the building, but those charges would be shown against the subdivisions of the account benefited, as called for by the Construction Schedule.

This gives the charges against the different subdivisions, the sum of which is the charge against the account, which goes to the ledger. This same idea would be followed out with the charges for labor.

With these detailed charges properly recorded, the next step need not be taken until the routine work of the month has been taken care of.

A special auxiliary record is advisable for recording charges against construction accounts in accordance with the subdivisions called for by Construction Schedule. Loose leaf sheets about 8 in. × 14 in. in size will probably answer the purpose, a separate sheet to be used for each account each month that it is active.

The headings to the columns on these sheets are left blank, to be filled in as required; the various columns on the sheet are totaled each month and the footings carried forward to next month's sheet until the account is closed.

Insurance Based on Book Values. When the compressor house is completed, by referring to these detail

*San Antonio, Tex.

sheets the cost would be something like this:

Excavation, $200; grading and filling, $100; foundations, $450; superstructure, $2,000; electric wiring and fixtures, $100; painting, $125. Total, $2,975.

The total cost shown corresponds with the ledger account for this piece of work.

A mining company carrying insurance on 80 per cent. of the value of their buildings and equipment as shown by the ledger accounts and paying a rate of $1 for this particular building, would pay on a valuation of $2,380, the premium of which would amount to $23.80 per annum.

To determine the insurable value of a building or its equipment, it is necessary to eliminate from the cost as shown by the ledger account, all expense incurred, the results of which would not be destroyed or damaged in the event of fire.

To carry insurance on holes in the ground appears to be a careless expenditure of money and still that is just what is being done, not by a few, but by a great many mining companies.

Excavations for mine buildings will not be destroyed even if the buildings are totally consumed by the flames. After the conflagration is over, the hole in the ground will be found intact and when the debris is removed will be as good as new.

The foundation of a building is another item that will withstand the ravages of fire and while it may be slightly damaged, it remains a foundation on which to rebuild.

The work of grading and filling in around the foundations of a completed building, while not expensive, is generally necessary and is part of the cost of the building. When a building is destroyed by fire it is not likely that the contour of the ground surrounding the place will be badly disfigured, even if it is, insurance could not be collected on the damage done. From these remarks it is evident that the insurable value of a mine building is not its cost as shown by the ledger account.

The insurable value of the building under consideration would be the cost as shown in the ledger, minus the sum of the items that would not be destroyed in case of fire, which are:

Excavation, $200; grading and filling, $100; foundations, $450. Total, $750.

Deducting $750 from the total cost of the building there remains $2,225 as the insurable value. At 80 per cent. of this or $1,780 and with a premium rate of $1 per $100 the annual premium would be $17.80, which shows a saving of $6 in the annual premium.

This illustrates very well the insurable value of a building at the time it is completed, but consider the value of the same building during the next 5 years. It is the policy of a well-managed mining company to depreciate the cost of its property, buildings, and equipment. This depreciation should also be taken as affecting the insurable value of buildings and equipment.

Assuming that the compressor house cited is either a frame structure or covered with corrugated iron, the natural life of such a building may be ordinarily taken as 10 years, which would call for a yearly depreciation in value of 10 per cent. Applying this rate of depreciation to $2,225, the insurable value of the building when completed, we have $2,002.50 as the insurable value at the end of the first year, $1,780 at the end of the second year, and $1,557.50 at the end of the third year, at which time the amount of insurance to be placed on it would be $1,246 and the annual premium $12.46. At this time the saving would be $11.34 in annual premium as compared to the cost under the original method of placing insurance.

There is another feature that enters the insurance problem, which should also receive due consideration, and that is the additions to buildings and plant equipment. It might be found necessary at the end of the third year to build an addition to the compressor house to provide housing for new equipment. This addition, costing $1,000, is subdivided as follows:

Excavation, $75; grading and filling, $25; foundations, $150; superstructure, $700; firing, $20; painting, $30. Total, $1,000.

Deducting $250 the cost of the non-insurable items from the total cost, there remains $750 as the insurable value of the addition which should be added to the insurable value of the main building at the end of the third year, making it $2,307.50.

It now becomes necessary to change the annual rate of depreciation, and under the new conditions the insurable value of the building at the end of the fourth year is $2,010, and at the end of the fifth year $1,712.50.

Carrying insurance at 80 per cent. of the value, or $1,370 as the insurable value, the annual premium is $13.70.

Thus, at the end of the fifth year there is a saving in the annual premium of $10.10 over the cost in the example first pointed out.

While I have endeavored to make plain the possibilities for reducing the amount of insurance carried with a corresponding reduction in the cost thereof, for a mine building, the same principles applied to plant equipment will give satisfactory results also.

The idea of getting at the true insurable value of mine buildings and equipment, considering additions thereto and the ordinary rate of depreciation upon them and placing insurance in accordance with these facts is well worthy of the attention of mine managers.

In the California oil fields the depth of the oil sand from the surface is from 700 to 4,000 feet. Its thickness is from 100 to 400 feet, and its dip from 40 to 20 feet in 100. The wells cost from $4,000 to $70,000 each. It has been definitely determined that water occupies the same sands at lower depth and as the oil is removed water creeps up and it is necessary to shut off the water to prevent its flooding the other sands not yet drained of their oil. This encroachment is termed "edgewater" and has ruined several oil producers.

"Bumps," Their Cause and Effect

A Description of Roof Movements in Mines at Coal Creek, B. C., that Have Resulted in Some Serious Accidents

*By John Shanks**

IN THIS paper no attempt is made to advance any new or original ideas in reference to roof movements, but rather to apply accepted theories† to explain the cause of the bumps which have been of common occurrence at Coal Creek, and which during the years of 1907-08 resulted in several fatalities.

Bumps have been mostly, although not entirely, confined to No. 2 seam. This seam is worked from Nos. 2 and 3 openings on the south side of the creek, and from No. 9 opening on the north side. All the fatalities occurred in No. 2 mine, and in every case, in places near to and approaching the gob of old districts from which the pillars had been extracted, as shown in Fig. 1.

The approximate section of the strata in the vicinity of the abovementioned old districts is as follows:

A superincumbent strata, approximately 1,650 feet thick. It contains several coal seams, each seam being overlain with strong sandstone and conglomerate beds ranging in thickness from 10 to 40 feet.
Roof rock 80 to 100 feet (of very hard, flinty sandstone).
Small seam of coal (6 to 15 inches).
Strong binder 18 feet.
Fairly hard clod or binder next to No. 2 seam, from 0 to 6 feet in thickness.
No. 2 seam, 5 to 7 feet of hard compact bituminous coal. Bottom, 6 to 12 feet of mixed shale and coal varying in strength as the shale bands vary in thickness.

At the time the writer took charge of the Coal Creek mines as manager in January, 1910, "bumps" were the subject of much discussion among the officials and miners. The prevailing opinion was that gas outbursts had something to do with their cause. The disastrous gas outbursts in the adjacent Morrissey coal fields, and the fact that each large bump was accompanied by the effusion of gas in large volume in the immediate vicinity, may have been in part responsible for this theory.

The writer is of the opinion that the cause of bumps in this mine was due to the pillars formed by the first workings being of insufficient size to resist the strains thrown on them by the jerky irregular working and the subsidence of the strong hard roof in the adjacent pillar area.

To the writer it seems ridiculous to give a fixed rule to regulate the size of pillars to be left to support and protect a shaft or workings. In support of this contention, reference may be made to, say, half a dozen recognized textbooks, in which formulas are given in this respect. It will be found that the variations will be as much as 100 per cent. In all cases the local conditions, especially the nature of the overlying strata, should govern the size of the pillars, in order to recover a large percentage of coal left by the first workings. The subsidence of the roof after the extraction of the pillars is always a matter of anxiety.

The writer, when mining engineer for the Whitehaven collieries, Cumberland, England, had experience of the behavior of a strong roof when breaking. Here a large area of the main band seam, 12 feet thick, with a strong sandstone roof from 40 feet to 60 feet thick, lay between Wellington and William collieries. The mine management started to pillar this section, but were required by the proprietor's engineer to leave three rows of pillars (pillars 75 feet square) on each side of the main heading, which was to be maintained as a permanent or traveling road between Wellington and William collieries. The pillars were cheaply and quickly extracted. The supports of the roof (8-inch square Norway props) were left. The writer has a recollection of almost being lost while attempting a short cut through this small forest of standing timber. This large area of 20 acres of exposed and unsupported roof (except for props) stood for months without showing signs of "weighing"; but suddenly, in a night, the squeeze came, and the rows of pillars left on each side of the heading were crushed to powder.

The caving of the strong roof in this area set up a lateral movement to the dip, where about a square mile of very small pillars had been left from former workings. The whole district was set on a slow creep. Bricks in arches were ground to dust. The management had ultimately to abandon this district of the coal field, and reopen it by a circuitous road. After this experience it was decided that no pillars should be extracted nearer than one panel of fifteen pillars from a main haulage road. If this sudden collapse of roof had happened at Coal Creek it would have shaken all the frame houses in the camp and would have been termed a "bump."

The worst bump experienced at Coal Creek No. 2, took place on the 31st of July, 1908; four lives were lost. The main dip entry was caved for 400 feet, as at Place No. 4. Owing to the presence of gas, the rescue party had great difficulty in reaching some miners who were beyond the subsidence. The miners were found near a leak in the air line. The writer attributes the effusion of gas in large volume to the release of the occluded gases in the 60-foot pillar on the right side of the engine plane, caused by the severe crushing, and to the heaving of the pavement of shale and coal. The pavement at all times gives off much gas.

In July, 1907, a man was killed in working place No. 1. The bottom had heaved and the coal had crushed, a little clod rock was down, but the main roof had not settled, as the timber still stood with the feet of the legs thrown in toward the track.

In October, 1907, a man was killed in working place No. 2. There

*Canadian Mining Institute, 1913.
†Trans Inst. M. E., Vol. 44, p. 531.

was no apparent settlement of the main roof, but the coal was crushed and the bottom had heaved.

In June, 1908, two diggers and a driver were killed in working place No. 3. The bottom had heaved violently, the pillar was crushed, and the rock packs at the sides were thrown in. The main roof had not apparently settled, as the cross-cut bridge stick was left standing.

Bumps were frequent without causing accidents. Miners were often thrown several feet from the face and no apparent damage was done to their working places. The men, if not "gassed out," would immediately resume work.

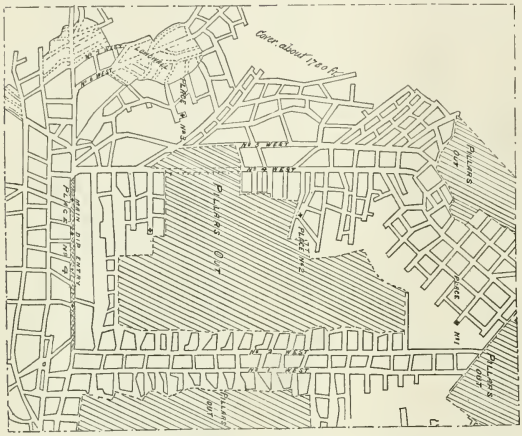


Fig. 1. Map of Workings, Showing Location of "Bumps."

Loaded cars were often thrown half across the road. In most cases a little heaving of the bottom would be noticed, and a little extra gas was given off.

In No. 6 west, two 4-foot cogs, 7 feet high, having 16-foot booms resting on them (other end of booms on props) were moved over bodily about 3 feet, without a stick used in their construction being displaced. These cogs had been in their places three weeks and were firmly wedged.

In September, 1912, a bump took place which shook the houses in the camp considerably. On examination it was found about 1,200 feet from the mine mouth on the deeps road. The pavement was heaved violently opposite a spot where a pillar should have been, but which for some reason had been extracted. The place was filled with muck. In this case there was no apparent settling of the main roof, or evidence of roof caving; the adjacent coal pillars were not crushed. The muck replacing the pillar was thrown on to the main road. For some years past there have been no working places in this seam, nearer than a distance of 1,500 feet. No. 1 seam, 120 feet above, was being worked on the pillar-and-stall method. The pillars were 150 feet by 300 feet, but in this seam there were no evidences of crush.

The workings in No. 1 had just reached a little beyond No. 2 engine plane, when the bump took place.

In explaining this last bump, the writer puts forward Halbaum's theory of horizontal force in the strata. The bottom could not have heaved so violently by a downward force, without such force pulverizing the adjacent pillars of coal, through which it must have acted. The releasing of gas pressures, etc., in No. 1 seam, must have set free (to quote Halbaum) "the supercompressions in the beds below," allowing them to exercise the property of resilience or spring. Only by adopting this theory can cases of the movement of cogs, cars, and men (without any apparent displacement of strata) be accounted for.

The roof in the area pillared between No. 3 west and No. 4 west heading, would, at a certain period act in the form of a beam supported at both ends. The lower strata being in a state of tension, and the upper in a state of compression, the lower strata would break and cave in the form of an arch. This would leave the solid coal in No. 4 west in a state of high compression, caused by the action of this huge rock lever. When the workings were turned out of No. 4 west toward the gob area they would so weaken the coal area supporting the compression forces as to cause crushing of the coal by sudden jerks, which would be caused by the sudden changing of the forces in the upper rock lever strata from compression to tension.

In the case of the accident in place No. 3, No. 6 west was opened up longwall, and an area of coal 150 feet by 250 feet had been worked by this method, before the pillar-and-stall method was again resorted to. This left 200 feet of solid coal between the longwall area and the goaf of No. 4 west. In the middle of this area the bump took place. The longwall workings would induce a severe roof strain leaning forward toward the goaf of No. 4 west. This strain no doubt merged into actual fracture, and threw the dead weight of a large, loose, roof area on the pillars, thus causing the effect produced at the time of the bump. In the section of this seam worked from No. 3 opening, the writer worked on the longwall system, and found that by carrying a 300-foot straight face

the roof action after the first break, was steady and devoid of any undue bumps.

This was also the experience in 5th east section of the rock tunnel works.

Packer No. 5 Mine Fire

A fire due to either a delayed fuse or a premature blast which released some slow burning dynamite that ignited some old, decayed timber was discovered in the chute of the West Holmes vein of No. 1 sectional tunnel in the second level of the Packer No. 5 colliery about 1 mile east of Girardville, Pa., by Assistant Mine Foreman Michael Carden, about 3 o'clock in the afternoon of September 3.

The following account appeared in *The Employes Magazine* of the Lehigh Valley Coal Co.

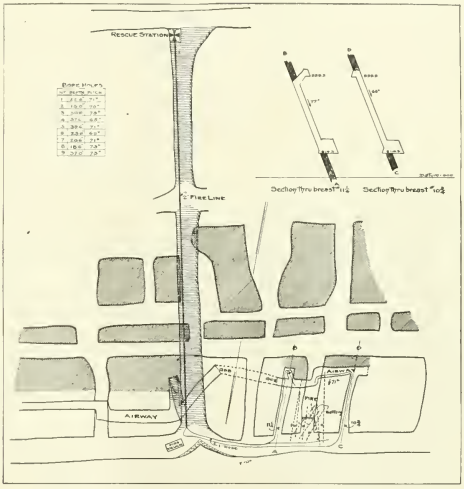
The officials on learning of the serious nature of the fire immediately attempted to draw it from the chute, but owing to the presence of a large amount of old timber and big lumps of material, this method was found impracticable. It was then decided to extinguish the blaze with water. A 2-inch pipe line running from the shaft through the main tunnel to the Seven-Foot vein, and east in this vein to a point opposite the No. 1 sectional tunnel, was being used by the Portland Contracting Co. to supply compressed air to their drilling machines in another tunnel which was being driven east of this location.

A connection was made into this air pipe from the column in the shaft, which is 500 feet high, the line broken opposite the No. 1 tunnel, and a 2½-inch pipe run from this point to the fire. Mine water was used in preference to the water from the Girard Water Co.'s reservoirs, which, on account of the prolonged drought, were very low. A connection to the reservoirs was made, however, ready for use if necessary. An electric pump which is stationed at the colliery all the time was also equipped for service if required.

While the water connections were being made, nine holes were drilled from the gangway up through the loose material in the chute with 1-inch pipe, with a drill connected on the end, the section of the pipe immediately back of the drill being perforated in order to allow the water to percolate through the material to the fire. These drill holes proved successful in holding the fire in check. Had this attempt failed and the fire reached the area above, the only recourse would have been to flood the mine with water.

In order to confine the fire between the gangway and the airway, which is located 40 feet above, two narrow chutes were started from the gangway up to the airway, one in the pillar on each side of the chute which contained the fire. This work was extremely difficult and progress was slow. The chutes were finally driven through to the old airway, which was found open for a short distance to the chute which contained the fire. It was then necessary to forepole all of the ground between the face of the airway on the inside to the face of the airway on the outside of the fire-chute. This task also was very tedious and slow, requiring considerable caution on the part of those in charge. A connection was finally made between these two points and a series of perforated pointed pipes inserted into the material in the chute, through which water was continually played on the fire until it was declared completely extinguished on September 12.

While the shift were engaged in their work the following first-aid and helmet men were continuously on the scene, in order to be in close touch with the situation in case of emergency: F. C. Benfield, M. W. Price, Thomas Brown, Charles Calvert, John Eye, Morris Fludder, James Ryan, and James Bradley. No one sustained any injuries whatever.



Method of Extinguishing Packer No. 5 Mine Fire

Among the officials who were in constant attendance were Thomas Thomas, mining superintendent; J. M Humphrey, mining engineer; H. J. Heffner, division superintendent; J. F. Barnhard, division engineer; B. S. Daddow, and Edward Williams; Mine Inspector J. A. O'Donnel; Col. James Archbald, engineer Girard Estate, and Henry H. Weller, supervisor Girard Estate; also H. H. Crum,

J. R. Kock, Lee George, J. Hinkle, W. H. Allebach, and H. G. Minnich.

At Packer No. 5 colliery is posted the following letter, written by E. M. Chase, vice-president and general manager of the company, who was on the scene practically all the time, commending the brave fire fighters:

"The Management desires to convey to all those who took part (in whatever capacity) in the work of extinguishing the mine fire at Packer No. 5, its sincere appreciation of the earnest, intelligent, and successful efforts put forth. The activity and enthusiasm displayed was characteristic of officials and employes alike, and illustrated once more the interest and loyalty of the organization, of which we are all so justly proud."

Air-Hammer versus Rotary Drills

By Pol Dunaime, E. M.

A comparison between the capabilities for the air-hammer drill and the hand-power rotary auger drill was made at the "Charles Ledoux" shaft of the Anzin company's mines, Anzin, France. The air-hammer drill caused no loss of time, since it did not require mounting or dismounting. In general, the air hammer is held in the hand, but it may be maintained in equilibrium with the help of a small diameter rope thrown over a timber or collar above, to which a counterpoise is fastened. The drill steel, when hollowed through the center for expelling cuttings from the hole by compressed air, creates too much dust, and was replaced in France by heavy steel with helicoidal grooves.

The hand drill used was a screw borer with triangular thread, turning in a bronze nut, held in a supporting socket, in a sliding frame which is jacked tight between the floor and roof. Comparisons were made first in schistose rocks *A* of moderate hardness, and then in coal *B*.

A. In this case, two parallel headings, whose areas were 6 ft.×7 ft. and 650 feet apart, were started at the same time in schistose rocks, each driven by two gangs of men composed of two machine men and two car loaders.

The shifts were 10 hours long, one machine man acting as foreman, and also loading and firing the shots. The explosive used was a very strong gelatine dynamite whose composition was as follows:

	Per Cent.
Nitroglycerine	82
Gun cotton	6
Potassium nitrate	10
Charcoal	2

Cars were used in the headings to facilitate transportation of the broken material.

In No. 1 heading five pneumatic hammer drills were used, each driller using the hammer allotted to him and for which he was held responsible, but if he kept it in good condition he was given a premium of $1 every 2 weeks.

The price paid for driving the heading was $1.85 per foot, with a premium based on a rate of $2.70 per foot for all ground broken over 5.75 feet per day.

No. 2 heading was driven by two hand boring machines and the price paid for driving the heading was $2.13 per foot, but any advance beyond 4.7 feet was paid for at the rate of $4.25 per foot.

The best fortnightly advance averaged 7.216 feet per day, and the cost of driving 1 foot was as follows:

Cost of Driving 1 Foot in Schist

	Air Hammer	Hand Drill
Wages	$1.800	$2.346
Explosives	.654	.609
Repairs	.005	.007
Amortisation	.160	.001
Compressed air	.025	.000
Total cost per foot	$2.644	$2.963

From this it will be noted there was a difference of about 32 cents per foot in the cost of driving between the air-hammer and the rotary hand drill. The deduction is, that the harder the rock the more the cost will be in favor of air-hammers.

B. In this case the headings were driven in coal, making conditions the same for both crews and drills. The price paid for driving headings whose areas were 6 ft.×4 ft., was 50 cents a foot with a premium of $1 per foot if more than 6 feet were driven a day; and, in addition, coal was paid for at the rate of 32 cents per ton.

The results given extended over 2 weeks' time, and are in favor of the rotary hand drill, showing again that the advantages of air drills is in direct ratio with the time occupied in drilling, on account of the hardness of the rock. In both cases one hole about 6.5 feet deep was bored daily. This was accomplished in 35 minutes by the air drill, but it required 1 hour to drill the same depth with the rotary hand drill. The daily advance was 9.97 feet with the hammer and 10.4 feet with the rotary drill. During the time of the contest the hand drillers broke 42 more cars of coal than the air drillers, although they worked 2 days less.

The cost of driving in coal is analyzed as follows:

Cost of Driving 1 Foot in Coal

	Air Hammer	Hand Drill
Labor	$1.251	$1.285
Explosives	.104	.076
Repairs	.001	.002
Amortization	.025	.002
Compressed air	.036	.000
Total cost per foot	$1.417	$1.365

[In anthracite collieries where the headings must be driven partly in coal and partly in rock, the air hammer has advantages over rotary hand drills which will show much better on the cost sheet than in the case of the French tests. It is very doubtful if any advantage is to be gained by using air hammers in bituminous coal.—Editor.]

California oil still maintains its position as the chief fuel of the Pacific Coast states, and will continue in this position for several years yet. However, it is expected that when the Panama Canal is opened there will be a great number of coal burning vessels enter the Pacific side of the canal and these will require coal for fuel. The opening of the Alaska coal fields by the Government is hoped for, as this will stimulate trade along the entire coast as well as vigorously develop the much "conserved" Alaska.

The Rheolaveur Coal Washer

A Form of Washer that Is Said to Have Some Peculiar Advantages Especially for the Washing of the Smaller Sizes of Coal

By Leo Dorey Ford, B. Sc.*

THE construction and operation of the "Rheolaveur" is based on the following principles: If unwashed coal is carried by a current of water along a trough of suitable inclination and dimensions, a classification of the particles according to their relative volumes and specific gravities will tend to take place. Supposing that the coal or mineral is first classified by volume, the subsequent trough classification will be by order of density alone: the particles of the highest density will form a layer on the bottom and near the upper end of the trough, whilst the lighter particles will separate out in layers further on in the trough, according to their various densities. If now, the bottom of the trough, shown in Fig. 1, is provided with a number of openings or slits *a*, the heavier particles will tend to fall through such openings, while the lighter particles will be carried over them. It is not, however, possible to arrange the inclination of the trough, the speed of the current of water, or the breadth of the openings, in such a manner as to separate cleanly the particles of different density; but if ascending currents of water at suitable constant velocities are led into a series of chambers placed beneath and connected with the openings *a*, the fall of the lighter particles may be arrested and carried back into the trough by means of these ascending currents, while the heavier particles fall through the ascending current.

The Rheolaveur, constructed in its elemental form, as shown in Fig. 2, is simply a chamber, partly rectangular and partly pyramidal, having a dividing partition or wall across the upper portion of its breadth. The portion of the chamber on one side of this partition communicates with an opening *a* in the trough above, while the other portion communicates with a water pipe *b*. The bottom of the chamber or hutch is provided with a circular opening *c*. The action in the chamber is as follows: A current of water is admitted by the pipe *b* from a reservoir so arranged as always to maintain a constant head; this current first descends, then after passing under the dividing partition splits into two, one of which ascends and flows through the opening into the trough *a* above, while the other descends and flows out at *c*. The quantity or the velocity of this inflowing water is regulated by means of a suitable valve *d* placed on the pipe *b*. The ascending split has for its function the arresting and carrying back into the trough of the particles of lesser density which it is not desired should fall, and also to lift, in a certain measure, the main stream of water and materials in the trough above the opening *a*, thus lifting the lighter particles and further preventing their tendency to fall with the denser grains. These latter as they fall against the ascending current are flushed through the orifice *c* by means of the descending current. The orifice of discharge is fitted with a special valve, which forms another means for the regulation of the velocities of the ascending and descending currents. The size of the orifice is, in order to avoid loss of water, so adjusted as to be just sufficient to permit of the exit of the denser grains without causing obstruction in the chamber.

In practice, the employment of a series of chambers such as those described entails the unnecessary consumption of a large quantity of water, and leads to the complication of the apparatus and distributing pipes, and difficulty in supervision. To avoid this, a number of washing elements, each comprising an inlet compartment and an upward passage, are combined and arranged according to the various purposes for which they are intended, to discharge into a common chamber having a single orifice of discharge only. Fig. 3 shows diagrammatically a combination of two units, divided in the center by a partition, thus giving four openings *a*, from the trough for one orifice of discharge *c*. This kind of Rheolaveur is the one most frequently used. It may be employed for all sizes of coal from 0 to 2½ inches, for the elimination of the final waste products, or for the elimination of a mixed product to be rewashed. Fig. 4 shows diagrammatically another form of Rheolaveur, which is also a combination of two single elements; but, in this case, there are only two openings, *a*, from the trough for one orifice of discharge *c*, and only one water-inlet compartment. This kind of Rheolaveur is used for rewashing products already partly washed, or for the final elimination of the middling. The arrows in both cases show the directions taken by the various currents of water both in the trough and in the Rheolaveur.

Fig. 1 Fig. 2

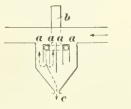


Fig. 3 Fig. 4

The orifice of discharge is fitted invariably with a valve made of several flat disks placed one above the other as shown at *a* in Figs. 5 and 6, each having in the center a

*Abstracted from Vol. 41, Part 2. Transactions of The Institution of Mining Engineers.

circular conical hole, the smaller diameter of which, in the case of an upper plate, is equal to the larger diameter of the hole in the next lower plate. The complete cone thus formed affords an easy exit for the materials discharged. The disks

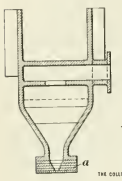


Fig. 5

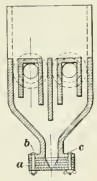


Fig. 6

are attached to the bottom of the chamber or hutch by means of a flange and two bolts *b* and *c*, Fig. 6, one of which serves as a pivot and the other for securing the disks firmly in place. The size of the orifice may be adjusted as desired by swinging back or replacing, as the case may be, one or more of the disks and securing the rest by means of a thumb-nut. Figs. 5 and 6 illustrate an actual Rheolaveur constructed for washing coal of sizes varying from 0 to ¾ inch. The openings in the trough are 1½ inches in breadth, the height of the apparatus, between the top of the discharge valve and the bottom of the trough being 18 inches, and the maximum size of the orifice of discharge 2½ inches. The weight of the whole apparatus, which is made in one casting, is about 280 pounds. For larger sizes of coal the openings in the trough vary up to 4 inches, the rest of the apparatus being in proportion. For the largest sizes the central partition is done away with, leaving one central opening, 4½ inches in breadth and two lateral openings each 4 inches. There are thus three openings for one orifice of discharge. The breadth of the Rheolaveur for all sizes and kinds depends on the breadth of the trough in which it is placed, which in turn depends on the quantity of coal to be treated.

In another Rheolaveur shown in Figs. 9 and 10, the washing arrangement is, in effect, the combination of two single units, the first of which is closed entirely at the bottom by a diaphragm *a*, which forces all the water which enters the inlet compartment into an upward stream, which is again deflected into a horizontal direction across the whole breadth of the trough by means of a deflecting plate *b*, placed over the top of the ascending passage *c*. Arriving at the end of the plate *b*, the horizontal current meets the ascensional current from the succeeding element, the particles which adhere to one another being, by this arrangement, broken up, and the efficiency of the ascending current from the second element greatly increased. Each orifice of discharge is fitted with a similar valve to that already described. This Rheolaveur is only employed for washing fine material and may be composed of from two to six double elements, according to the position

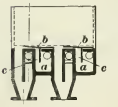


Fig. 7

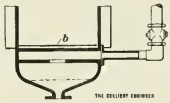


Fig. 8

and the purpose of the apparatus. If required at any time, this apparatus may be worked without the horizontal current, this often being the case when the coal is clean and contains little dust.

One curious point in connection with the dust is that, although the principle of the Rheolaveur is one of a separation by equivalence, yet in practice these separators are found to wash not only the larger grains, but the dust as well, as may be shown by the two analyses of the shales discharged by two machines of the kind shown in Figs. 7 and 8 and recorded in Table 1.

In practice several Rheolaveurs of various kinds and sizes will be arranged in series in the main transport troughs, the numbers, sizes, and arrangement depending on the quality and the size of the coal to be treated. For example, supposing it is desired to wash a coal into four classes, there will be a separate trough or series of troughs for each size, forming a separate independent washer for that size. The number of Rheolaveurs required in each

Table 1. Analysis of Shales Discharged

Size of Grains Inches	Weight Per Cent.	Ash Content Per Cent.	Mean Ash Content Per Cent.	Size of Coal Inches
0 to $\frac{1}{8}$	12	58.00	67.49	0 to $\frac{1}{4}$
$\frac{1}{8}$ to $\frac{1}{4}$	18	71.08		
$\frac{1}{4}$ to $\frac{1}{2}$	70	73.38		
0 to $\frac{1}{4}$	3	52.52	62.68	0 to $\frac{1}{2}$
$\frac{1}{4}$ o $\frac{1}{2}$	4	59.46		
$\frac{1}{2}$ to $\frac{1}{4}$	36	67.56		
$\frac{1}{4}$ to $\frac{1}{2}$	57	71.20		

washer will depend on the cleanliness and size of the coal. The amount of coal to be washed affects only the breadth and height of trough and the breadth of the apparatus, and not the number of appliances. The length of the trough between the various Rheolaveurs will depend on the difference in the specific gravities of the minerals to be separated, but in practice 6½ feet is found to be the maximum necessary, 3¼ feet being the usual distance. The inclination of the trough also affects the distance, but these points are details of design, and do not affect the principles.

Each washer for each size may include one or more transport troughs placed one above the other, each containing a series of Rheolaveurs for washing the discharged products from the Rheolaveurs in the trough above. In other words, the Rheolaveurs may be arranged in cascade. The disposition of one such washer for an aggravated case, is shown di-

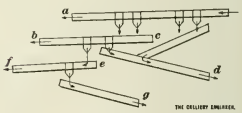


Fig. 9

agrammatically in Fig. 9. Following this scheme, *a* represents washed coal of the first quality, *b* washed coal of the second quality, *c* a mixed product to be rewashed, *d* final waste

products, *e* a mixed product to be rewashed, *f* coal of the third quality, and *g* coal of the fourth quality, namely mixed slate and coal. Thus, the disposition of Rheolaveurs in cascade presents the following advantages: (1) The coal undergoes a steady progressive cleaning. (2) All apparatus and motive power necessary to elevate the products to be rewashed is done away with. (3) The water discharged with the products to be rewashed is utilized to carry away the grains in the trough below, where the products are treated by Rheolaveurs of the same kind as in the trough above, but of smaller dimensions. As the dimensions are smaller, the size of the orifices will be reduced, and, therefore, for the same velocity the quantity of water in an ascensional current will be less. This not only entails a saving in water, but prevents as well the exaggeration of the main current in the trough, and assists the classification of the materials. (4) By the employment of a series of troughs, the products from each may be of different densities, and so of different qualities, and all qualities may be kept separate or mixed together at will.

All the water necessary may be supplied by a reservoir of from 10 to 15 cubic meters capacity, placed at such a level as to give a head of 13 to 16¼ feet, which must be kept constant. This can easily be effected by means of an overflow pipe or some other similar device for keeping the water level in the tanks. The water may then be led to the troughs and the various Rheolaveurs by means of water mains placed conveniently above each series of troughs, and by means of smaller distributing pipes leading from these mains, as shown in Fig. 10.

In comparison with jigs, the water consumption with Rheolaveurs shows a considerable decrease for all sizes of coal up to, approximately, 1½ inches, but from 1½ inches to 2⅓ inches, above which size it is seldom necessary to wash, as the coal can readily be hand picked, the water consumption shows a considerable increase. The extra power for the pump is amply compensated for by the many savings in other directions. If desired, a double chamber with two automatic discharge valves may be placed under the Rheolaveurs for the larger sizes. The water consumption is, by this means, greatly reduced and gives a direct saving

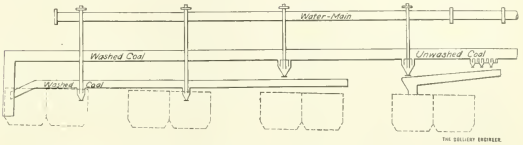


Fig. 10 Elevation of Washing Plant

for all classes up to 2⅓ inches in size. In any case, however, as the bulk of the water is used over and over again, the water consumption is not of great importance, as the washery can be so arranged that little water is lost, and this loss can be compensated for by a small main from an auxiliary source.

It will be readily seen that the simplicity of the Rheolaveurs, the ease with which they can be regulated, and the wide limits possible for the same machine, render them very suitable for washing coal of varying nature. In the case of a central washery dealing with coal from various hoppers, each containing mineral of different quality, tests can be made for each class of coal, and by opening or shutting the inlet valves, the velocity and quantity of the currents of water may be easily regulated to meet the requirements of the particular coal under treatment. For greater convenience, all the valves may be graduated, and the amount of turn necessary for each may be found by trial and tabulated for each class of coal and for each individual apparatus.

When a clean coal is being treated, all the Rheolaveurs of a series may not be required, and with a little experience it can be readily found which appliances are necessary for any particular class. The remaining appliances may be cut out until wanted, by closing the orifice of discharge and the water-inlet valve.

For existing washeries, isolated Rheolaveurs may be found useful, either for rewashing the waste products from jigs, etc., or in order to increase the output of the existing plant with a minimum of expense. As an example, the following case is quoted: At a washery belonging to the Compagnie des Mines de Dourges, where jigs are employed, it was found that the trough for the unwashed fines, partly rid of dust, and of a size from 0 to ½ inch (0 to 8 millimeters), was too small and in consequence overflowed frequently. One Rheolaveur having four openings and four orifices of discharge, was inserted in the trough before the point of overflow. This was found to remedy the trouble, and an elimination of a large proportion of the waste dirt, with an average content in ash of 76 to 80 per cent., has enabled the washery to increase its output by 15 tons per hour, or by 400 tons per 24 hours, without adding anything to the supplementary costs of washing. The cost of a single Rheolaveur varies from $75 to $100.

The principal advantages claimed for this system of washing are as follows: (1) That a washing apparatus, constituted of current washers alone, requires no transmission of movement for its operation, this involving (*a*) a considerable reduction in the initial cost of installation, (*b*) economical operation, and (*c*) considerably reduced maintenance charges. (2) It is particularly applicable for large outputs, and in such installations would greatly reduce the space and height occupied by other forms of washers; it permits of combination with any other

kind of washing apparatus, or in maintaining the same production while diminishing the occupation of space by dispensing with part of the existing plant. (3) The comparatively small space occupied by the plant, the facility with which all the various members may be grouped together, and above all the extremely simple operations of the Rheolaveurs, permit of an easy supervision and a reduction in labor. (4) The operation is characterized by the production of an extremely small amount of sludge, which in the case of jigs or apparatus of the piston type, on account of the multiple movements, is very inconvenient. In addition, as the water evacuated with the waste products is relatively clean, the waste products do not carry away any fines which by reason of their commercial value are worth recovering. (5) The system admits readily, and with little cost, of all the variations and combinations that may be desired, and by simply placing another trough, containing one or more additional Rheolaveurs, underneath all or any of the orifices of discharge, the material evacuated may be washed again until the desired results are obtained. (6) The regulation is very simple, and as there are no moving parts in the various appliances, there is no possibility of a breakdown or stoppage for repairs. (7) Samples may be taken at any of the orifices of discharge and an assay made, thus giving an exact indication as to the regulation and efficiency of each apparatus. (8) The water consumption is on the whole, no greater than with the piston washers, and may be considerably less.

To illustrate the rapid depreciation of coal mining machinery, a mine manager recently said: "The only piece of machinery that I know of, that will depreciate in value as quickly as coal mining machinery is an automobile." He had evidently tried to sell a "perfectly good" second-hand car.

Electric Mine Lamps

In every mine there is a light problem, for the miners must be absolutely dependent upon artificial light in the execution of their work.

The electric lamp is a real safety lamp and if all workers were equipped with them and the so-called flame safety lamp placed in the hands of experienced men for the testing of gas only, accidents in the mines would be reduced to a minimum. Among other means of mine illumination, the United States Bureau of Mines approved the Hirsch lamp as permissible for use in gaseous mines. The lamps are so constructed that no matter how the reflector is crushed or punctured, or the glass broken, the circuit is cut off before the bulb breaks; making it absolutely safe in explosive atmospheres. It has also been improved in that the cap lamp can be unscrewed from its socket and attached to the battery direct forming a practical hand lamp.

Mr. H. H. Clark, of the United States Bureau of Mines, said in an address before the Coal Mining Institute of America:

"There are a number of qualities that an electric lamp must have in order to make it acceptable for mine use. Chief among these is safety. The principal reason why the Bureau of Mines advocates the adoption of the electric lamp is because fire and explosion hazards will be decreased thereby.

"The first requisite of a lamp is the production of light, and for mining service a lamp should burn steadily and with undimmed brilliancy for a certain number of hours."

Mr. F. J. Turquand, of London, England, recently read a paper before the London branch of the Association of Mining Electrical Engineers on electric mine lamps, in which he said:

"The main points in erecting a miner's electric lamp charging and repair installation are: (*a*) An electric supply at constant voltage through a circuit, the installation resistence of which is high and without liability to leakage; (*b*) absolutely accurate circuit and testing voltmeters and ammeters, including a main-circuit recording ampere and voltmeter, which should be recalibrated periodically and have frequent subsection fuses with a minimum margin; (*c*) strong benches and charging racks completely covered with stout lead or glass sheet; (*d*) facility for washing down with a hose, and quick drainage.

For the economical maintenance of a large number of miners' electric lamps the selection of right methods is important, and accurate observation and record of each individual cell vital to success. Considerable difficulty may arise in keeping all the batteries in uniform condition, from two causes modifying the hours of actual discharge—varying resistance of the electric bulbs, and the free use of the switch. Lamps should, therefore, be handed to the workmen with the light switched on and with instructions not to turn it off except in case of emergency. This practice insures a predetermined discharge and tends to lengthen the actual life of the bulb (which is less fragile when alight). It is also most necessary that the manufacturer's regulations for the maintenance of the battery be adhered to as closely as possible, in order to obtain the best results and the advantage of the manufacturer's guarantee.

It will be found that one of the largest items on the list of renewals will be bulb replacements, and in selecting the watt per candlepower efficiency of the lamp adopted, it must be borne in mind that the efficiency must not be high enough to shorten the useful life of the bulb by fracturing the filament or undue blackening of the glass, nor low enough to discharge the battery at too high a rate. Experience shows that the average life of 2-volt bulbs is 600 burning hours—or, say, when working four shifts per week, 3 months—and that it is desirable to test all the bulbs individually through a long-scale ammeter and use only those bulbs of the required efficiency."

Moistening Coal Dust

Safety Pamphlet No. 1—A Cautioning Notice Sent Out to Alabama Coal Operators

*By James L. Davidson, Secy.**

IN cold weather it is well to remember that the ventilating air-current entering mines (common ordinary atmosphere, the breath of life) is one of the greatest sources of danger in a dust bearing coal mine.

The superintendent and mine foreman may figure that it will take 2 months of winter to dry out the mine and make it dangerous, and that the steam jets, sprays, atomizers, and water lines can wait a few weeks longer until rush orders slack up a bit. "He'll put them in next week sure," but next week never comes. Dust explosions do come, and terrible is the visitation.

The air going into the mine is thirsty, and every revolution of the mine fan is drying out the dust, unless the necessary moisture is artificially supplied.

The air-current of the average size mine during cold weather (in this district) may carry out of the mine daily from 8,000 to 12,000 gallons of water (moisture) and it does not take long at that rate to dry out an enormous area of dust-laden territory.

And then remember, what a small amount of dry coal dust will propagate a tornado of fire, leaving death and destruction in its wake.

Experiments show that 1 pound of dust to 500 cubic feet of air is sufficient.

The nearest place to the intake dries out first, and the drouth creeps onward with surprising celerity until the incoming air has gathered its maximum relative saturation to the temperature of the mine, and so on until the uttermost recess of the mine is a veritable "Powder House," unless the natural yield of water in the mine sooner supplies the necessary humidity.

Short new entries near the intake or on a separate split dry out faster than longer old entries; and many dust explosions start or occur on short new entries.

It is difficult to saturate dry coal dust by sprinkling and pouring water on it. Especially is it difficult to reach and wet the dust that settles on the timbers, the walls and ribs, and in the gobs, crevices, and abandoned places. The air reaches every place and every recess, and coal dust will absorb some moisture from humid air. Therefore see that moisture is added to the air when needed.

Not in any wise disparaging such method, yet for the reasons above given, and because the same is rarely ever properly, thoroughly and with frequency done, spraying, sprinkling, and washing down with a hose when not persistently followed up, is apt to prove unreliable. Do not, however, abandon sprinkling and washing down with hose, for it will do lots of good, and furthermore, the law requires it—but don't rely upon it alone. Do both!

It is believed that in at least one Alabama case an explosion started shortly after the mine had been sprinkled and washed down. Why? Because under certain conditions it is possible to put the dust in suspension, and suspended dust is what explodes. Therefore, in sprinkling, a very fine, misty spray should be used, so that the dust will not be knocked into the air. Furthermore, a fine spray will saturate the dust quicker and more thoroughly than a heavy stream. Wet it so that the dust will not float in the air.

Fresh dust is generally dry, and therefore, all haulage ways and the face of every working place should be thoroughly sprayed every day, and all loaded cars should be wet down as they leave the rooms, or other working places. Dust once wet or saturated should never be allowed to dry. Keep it wet. Yes, so damp, at all times and at every place in the mine, that every sample of it taken sticks together when pressed in the hand. The mine foreman, fire boss, and superintendent should make the above test for dangerous dust frequently, if not daily, throughout the mine and especially along the intakes.

If you ask an experienced gas man what is the only reliable way to free a place of gas, he will answer "Put the air to it." Just so, the only way to free a mine of dust is to "Put the water (moisture) to it." Do it so that the dust in every place, crack, and crevice, in the mine becomes wet and stays wet. Of course the dust should not be allowed to accumulate. Clean it up and load it out daily.

You ask how to keep it wet. Did you ever notice how a glass of ice water sweats in summer? There's a reason for it. The moisture carrying capacity or saturation of air is limited to its temperature. This capacity decreases as its temperature decreases. So the warm air coming in contact with the icy glass is cooled and dumps its surplus load of water. Likewise, cool air upon being warmed will absorb all available moisture until its carrying capacity is reached. Inside mine temperature is practically the same winter and summer, and the air going through the mine quickly conforms to inside mine temperature. Consequently, the mine is dry in winter, unless artificially moistened, and wet in summer.

Therefore, in order to insure proper and necessary precipitation, and to prevent the mine becoming dry, the temperature of the intake air should be at all times (or at least during the night) 5 degrees higher than the temperature of the return air, and the humidity should be, if possible, greater on the intake than on the return. The intake air should have at least 90 per cent. saturation. This will necessitate warming and humidifying the intake air in winter and simply humidifying the intake air in summer. Cooling in summer may be desirable but should not reduce the temperature below the limit above prescribed.

*Birmingham, Ala.

The best method of heating and humidifying the intake air in winter is by projecting into the intake air small jets of steam or warm water. Steam is cheaper and more efficacious. Ordinarily, the exhaust from the fan engine is sufficient; however, when it is very cold, steam from the boilers may be necessary. Only experience at the particular place can govern.

A fairly good and economical heater and humidifier can be arranged by installing a line of pipe along each side of the intake about opposite the center of the coal seam. In order that the pipe may be afterwards used for other purposes the jet vents can be bored in the couplings, say three one-sixteenth-inch holes to each joint. The first vents or jets should be placed at least 75 or 100 feet inside the mine and the pipe lines should extend as much further as may be necessary to give the required results, remembering always that the first jets do most of the warming, and the others the humidifying. These jets should be received on small pieces of sheet iron and directed so as not to strike persons in passing. The pipe should also be safeguarded so as to prevent persons getting burned in passing. Valves should be placed to regulate the amount of steam used, and also at intervals along the line so that as much of the end of the line may be cut off as desired. The vents can be plugged with wood or reopened as desired. Experience will teach how to regulate the amount of steam required.

In summer when the outside air current gets warmer than the inside, the steam should be cut out, clean water substituted and forced through the pipes, having first attached fine sprays or atomizers at the vents.

In both cases the walls and roof of the entry close to the jets can be protected with lagging to prevent falls. Another thing, experience has taught that alternate wetting and drying is what causes the roof to weaken, and that most falls occur in early summer and fall; the mine having dried out in winter and then becoming wet in summer, or vice versa, causes these falls. The number of falls can be largely reduced by keeping the mine constantly moist throughout the year.

The most objectionable feature in using steam for humidifying is that it often produces mist or fog, which is often disagreeable and dangerous, when the main entry or haulage way is the intake. This can be avoided by cutting down the amount of steam in the day time, until the fog is not objectionable, and spraying with water on the haulage ways and at the working faces, then turning on sufficient steam during the night.

Where the air-current has a long way to travel, the humidity may not reach the farthest places. In that case, where practicable, install a few temporary auxiliary steam jets or water sprays on the intake of these splits or entries. If the air-course is used as the return, they can be installed in the first worked-out room on the intake; if the air-course is the intake, then they can be installed in its entrance, and thus avoid the objectionable fog or mist on the entry haulage way, or supplementing with atomizers and spraying.

Superintendents, mine foremen, fire bosses (and fan men if charged with looking after the humidifier) should be instructed in the use of the thermometer and barometer; and the temperature and humidity of the intake and return air should be taken several times during the day and night, and the amount of steam or water going into the intake regulated accordingly. Thermometers and barometers should be procured for their use.*

However, the best index after all is the simple test first above set out; that is, pick up a handful of dust and squeeze it, and if it sticks together it is wet enough, if not, the air needs more moisture.

The safest way of preventing dust explosions is to employ both methods of wetting the dust, warming and humidifying the intake air with steam and water sprays, and thoroughly wetting and washing down the inside surfaces, and working faces with a hose.

The idea is to prevent the air-current from taking water out of the mine and in addition thereto to supply the necessary moisture to wet the dust in every place, crack, and crevice in the mine; and to prevent the dust from getting into and floating in the air-current and from being dry so that it may be stirred up.

Fresh made dust will not be quickly moistened by the humid air-current, and should be sprinkled as soon as made, unless it falls on a surface so wet that it sticks. Furthermore, if the dust is allowed to accumulate, it will be that much harder to wet it through and sufficiently.

It is dangerous to rely on wet zones and intermittent careless sprinkling with a hose, because it produces a false sense of security whereas as a matter of fact, there is always enough dust left dry, in places not reached, and often floating on the water or dried out between sprinklings, to spread an explosion. Many explosions have occurred in just such mines. Another thing "pouring water on, or sprinkling, dry coal dust is like pouring water on a duck's back"; it runs off or forms in puddles, and does not wet the dust unless repeated often enough, and the dust will float and collect on the surface of the water and remain there perfectly dry for days. The only way to wet it by sprinkling is to sprinkle it successively from day to day until it is like mud and then keep it wet. In order to do this, great care must be exercised and the work must be systematic, thorough, and frequent, and must be assiduously followed up by the mine foreman, not only in working places, and entries but in air-courses and abandoned places. Water lines, with plenty of taps for attaching hose, should be run along the haulage ways up to the working faces and to other places that may need sprinkling. Clean water under sufficient pressure should be used.

In order to make the dust absorb and retain the moisture, a deliques-

*Upon request the Secretary will endeavor to furnish information and instructions on the use of the thermometer and barometer in coal mines, and the value of such practice. See United States Weather Bulletin No. 235. There are automatic regulators of steam pressure, which are controlled by thermometers and barometers, also automatic recording hygrometers, barometers, thermometers, and anemometers on the market.

cent salt, calcium chloride (not common salt, sodium chloride) may be used in solution for spraying roof and ribs, and by scattering it dry along the surfaces to be kept wet; but this plan is hardly practicable in Alabama.

The dangerous season rapidly approaches! Do you know personally whether or not your mine is dusty and dry? Go see for yourself. "Don't send a boy to mill."

Remember! Don't let your mine get dry! A dry mine is a dangerous mine. Where mines once are wet it is comparatively easy to keep them so.

OTHER PRECAUTIONS FOR PREVENTING DUST EXPLOSIONS.

In a mine working a coal that makes inflammable dust, the risk of a dust explosion can be greatly lessened by following these precautions:

Use permissible explosives where the coal cannot be wedged down, and use them in the ways suggested by the Bureau of Mines in Miners' Circular, No. 2.

Don't use black powder, dynamite, or any long-flame explosives.

Don't blast the coal "off the solid." Undercut it or shear it, and wedge it down if possible.

Don't drill the holes beyond the undercutting or shearing.

Don't fire two shots at once, except by electricity from outside the mine. Allow enough time between shots for the dust to settle.

When shots throughout a mine are fired after the shift by shot firers, they should be fired on the last of the air first, then successively toward the intake, so that the dust and gases from the earlier shots will not be carried toward and possibly ignited by the later shots.

Don't tamp shots with coal dust, bug dust, or small coal, whether wet or dry. Use clay or other material that will not flame.

Load out all coal dust or bug dust from the working places and do not let it collect along the roads. It is dangerous in the mine; it has value as fuel outside.

Use tight cars and keep the coal below the sides of the cars.

Flush the tops of the loads with sprays.

Wash the coal dust from the roof, ribs and timbers; or, if this is not done, keep the dust damp by making the mine "sweat" all winter as it does in summer.

Don't be satisfied with having some parts of the mine wet.

Keep all the mine wet, so wet that the roof and sides are beaded with moisture and the dust packs down on the floor and looks wet.

Don't let the gas accumulate in idle worked out or abandoned places in the mines.

BOOK REVIEW

A review of the latest books on Mining and related subjects

We are in receipt of the Engineering Index Annual for 1913. The *Engineering Magazine* has taken special pride in putting the book on the market within 6 weeks of the close of the calendar year.

The publications and transactions reviewed have been carefully scrutinized in order to raise the standard of the Index, for example, the proceedings of the Institution of Mining Engineers and the Faraday Society have been consigned to those divisions of the classification to which they seem most logically to relate.

The Index is so well known that it would be superfluous to say more regarding it. It can be had from the publishers, the *Engineering Magazine*, 152 Nassau Street, New York City. Price, $2.

The Electric Furnace, by Prof. Alfred Stansfield of McGill University, 400 pages, illustrated, published by the McGraw-Hill Book Co. at $4 net. The book is an ideal one on the subject, as its scope and arrangement are clear to all engineers, metallurgists, and even the layman. It successively deals with the history of electric furnaces, their classification, efficiency, construction, operation, and uses, concluding with a glimpse into the future of this rapidly growing member of the metallurgical industry.

Columbia School of Mines, 50th Anniversary

One of the greatest gatherings of engineers in the history of New York is likely to be seen on May 28, 29, and 30, when the School of Mines celebrates its fiftieth anniversary on Morningside Heights.

Plans are practically completed for the celebration, which begins on May 28 with a reception in the Gymnasium at which the alumni will be welcomed by the President of the University, the Dean of the School of Mines, the senior professor, Henry S. Munroe, the Chairman of the Celebration Committee, and their wives, while the other members of the faculty and the committee and their wives will assist. In the forenoon of May 29 there will be a big meeting in the Gymnasium at which President Nicholas Murray Butler will preside, and degrees will be given to prominent alumni of the School of Mines. It is also expected that there will be sectional meetings of the various engineering graduates in the afternoon, with the first lecture in the Charles F. Chandler Foundation by an eminent chemist, at which Doctor Chandler, the last survivor of the founders of the School of Mines, will preside. The celebration will close with a banquet to be held at the Waldorf-Astoria, at which Prof. James F. Kemp will preside.

Columbia is determined to make the occasion the greatest in the history of the University, and to this end, Dean Frederick Arthur Goetz, of the School of Mines, Engineering, and Chemistry, will visit the large cities of the United States, going as far west as the Pacific Coast and visiting a large number of cities where graduates of the School of Mines are located, to see them personally and invite them to aid in the celebration.

The Panel System in Ohio

New Methods of Mining in the Hocking Valley Coal Fields at Mine No. 22 of the Hisylvania Coal Co.

By Wilbur Greeley Burroughs

NEW mining methods are being introduced into the Hocking Valley coal field at the Hisylvania Coal Co.'s mine No. 22. The double-entry room-and-pillar method of mining, common to nearly all of the mines in the Hocking Valley, is done away with, and a panel system of mining, which, however, is based on the room-and-pillar method, is being used.

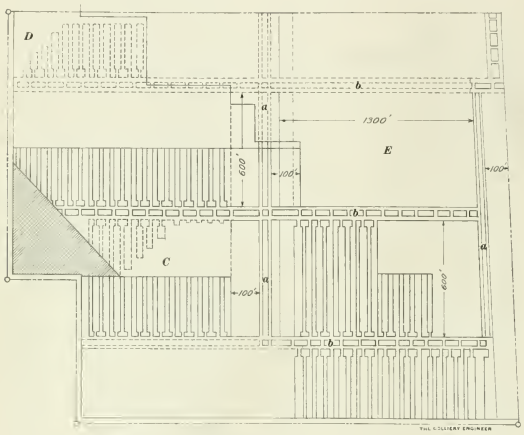


Fig. 1. Panel System of Room and Pillar Mining

The Hisylvania No. 22 mine is on the outskirts of the town of Glouster, Athens County, Ohio, on Sunday Creek, in the Sunday Creek division of the Hocking Valley coal field. On both sides of the flood plain of Sunday Creek the hills rise 300 to 400 feet high, intersected by narrow valleys. Near the base of one of these hills to the east of Sunday Creek, are situated the tipple and other buildings of the mine. Immediately west of the tipple, but also to the east of Sunday Creek, run the tracks of the Kanawha & Michigan Railroad. Just behind the tipple is the entrance to the mine.

The coal mined is known as the Middle Kittanning, Hocking Valley, or No. 6, coal seam. The seam is 12 feet thick, but the 5½ feet of somewhat poorer grade of top coal is left for the roof of the entries and rooms, the better grade of coal below being mined. It is used chiefly for domestic purposes, to which it is well adapted, being not only of excellent quality, but also black and glossy.

The coal and its surrounding rock formations dip toward the southeast at the rate of 24 feet to the mile. The massive, gray, rather coarse grained sandstone that overlies the slate under which is the coal, affords an excellent covering of 135 feet total depth for the mine entries and rooms. The fireclay forming the floor of the mine workings is shallow, and underlain by firm, interbedded sandstone and limestone; thus there is not much tendency toward the floor heaving.

To mine the coal, slopes were driven into the hill near its base until the coal was reached, and then the mine was opened. The main haulage slope has a 27-per-cent. grade, and is 620 feet in length from its mouth to the point where it becomes horizontal. The slope, which is 16 feet wide by 9 feet high, is lined with brick for the 150 feet it penetrates through the shale, when it passes into the massive sandstone formation. There are two tracks in the slope for a distance of 850 feet from the entrance to the mine, when the double track ceases and only a single track continues in the center of the entry. Going down the slope, there is cut every 60 feet in its walls a refuge hole for any one who may be walking in the slope when the mine cars are running. The slope and main-haulage entry are lighted by electricity.

The miners are not supposed to use the haulage slope in entering and leaving the mine, the air-shaft, which is 16 feet wide by 8 feet high, brick lined, and of a 35-per-cent. pitch, being used for this purpose.

The panel system of the room-and-pillar method of coal mining used is shown in Fig. 1.

The face entries *a* and butt entries *b* are driven on the face and butt cleats.

In the system used the double entries are 12 feet wide and 6 feet high. Coal pillars 30 feet wide are left between entries, and breakthroughs are made every 60 feet.

Each pair of face entries is 1,300 feet distant from the next parallel pair of face entries. A barrier pillar 100 feet in thickness is left along the face entries to insure the haulways against any trouble that may occur in the room entries; this pillar of coal is mined by either face or butt rooms after the haulway is no longer of especial importance. Butt entries are turned every 600 feet along the face entries. Rooms are turned from the butt entries, the room neck being 12 feet wide for 25 feet, when the room is widened. The length of the room is 300 feet. Breakthroughs are made every 60 feet, and are staggered.

The rooms alternate in having a single and double track. A single-track room, widening from both sides of the neck, is 26 feet wide, the track being in the center of the room. A double-track room, widening from one side of the neck, is 30 feet wide, a single track being laid on each side of the room.

The rooms are single and double track, alternating, for the following reason:

In the single-track room the gob is placed on either side of the track, as the room is driven forward. When the rooms are 300 feet long or one-half way to the opposite butt entries, the pillars of coal are drawn. The gob is then in the way, if the pillars are to be drawn from the single-track rooms. In the double-track rooms the gob is placed in the center of the room between the tracks. When the pillars are to be drawn, there is no obstruction between the coal and the miner. Therefore, the pillars are drawn from the double-track rooms.

The general rules for mining by the system employed at this mine are to drive the rooms from the north side of the entries, and as soon as these rooms are finished one-half way to the next parallel pair of entries, the pillars between the rooms are drawn to entry stumps. The rooms to the south of the double entries, during this time, will have only been necked. When the north room pillars have been drawn to stumps, the south rooms which have been necked will be worked, beginning at the far end of the entry, and as the rooms are

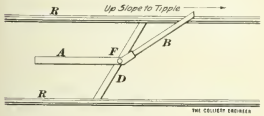


Fig. 2

completed, room pillars and entry pillars will be taken out at the same time. All pillar work is kept on a 45-degree line, as shown in *C* and *D*.

The above method does away with any creep that might occur; for in the first place, there is a solid body of coal left between the areas being worked; and finally, when those portions being mined are worked out, they will settle, so that mining the solid body of coal that was at first left intact will be easily accomplished without it being affected by the areas already worked out.

The coal is undercut by electric mining machines which make a 4-inch cut 7 feet deep across the face of the room. The mining machines run day and night. As the roof is firm and exerts no immediate downward pressure, the coal remains in position after the undercutting is completed. It is necessary to shoot the coal, which with loading of the mine cars is carried on only during the day.

Except on the slope, the haulage in the mine is entirely by electric locomotives. The power is obtained from a 225-kilowatt generator (a 100-kilowatt generator is about to be installed), which is driven by a Westinghouse automatic compound engine. The power plant has three 350-horsepower boilers for generating steam.

On the main slope of the mine, the haulage is accomplished by an endless-rope system, the mine cars being gripped to this rope when coming out and going into the mine. The haulage engine is of 150 horsepower.

The mine cars are gathered by electric locomotives, and brought along a 2-per-cent. grade to the main haulage slope where the endless rope commences. Here each car is gripped to that portion of the rope which is moving up the slope to the tipple. At the tipple the loaded cars are detached from the rope, run to a cross-over, dumped, and kicked back to the empty track, where they are gripped to the return rope going down the slope. The loaded cars moving up the slope at the same time are balanced somewhat by the empty cars returning into the mine.

Fig. 3. Street in Glouster, Ohio

At short distances in the center of the loaded track for the entire length of the slope safety devices are installed to insure against accident in case the rope should break to prevent the loaded cars from running backwards down the slope into the mine.

One of these safety devices is shown in Fig. 2, the description of which is as follows:

Arm *A* of iron, and arm *B* of wood, are fulcrumed at *F*, which is fastened securely to the track on the floor of the slope. *B* is raised sufficiently high above the floor so that the mine cars strike it as they pass up the slope. As a loaded mine car passes up the slope, striking *B*, *B* revolving on *F* moves downward, allowing the car to pass over it, the iron arm *A* at the same time rising slightly into the air. As soon as the car ceases

pressing upon B, the iron arm A falls to the floor of the slope, re-elevating B to its initial position. If the rope to which the cars are gripped should break, arm B would stop the car running backward down the slope by coming in contact with the rear end of the car. These devices are placed at short intervals, so that the car running backwards could not acquire much momentum before it came in contact with the arm B. There is therefore no danger of the car being thrown from the track as it strikes arm B, or of its breaking arm B, as it comes against it.

On account of the strength of the roof, no timbering is done in the main entries; but in the rooms, wooden posts are placed every 6 to 9 feet.

Ventilation, at present, is accomplished by means of an electric disc fan, but a 12- or 14-foot centrifugal fan is soon to be installed. There is a little marsh gas, CH_4, in the mine, as in nearly all, if not all, of the mines of the Sunday Creek district, but with good ventilation the danger from gas is very slight. There is also no danger from spontaneous combustion, for the mines are very wet, and the coal and coal dust are never dry.

The coarse sandstone which is in close proximity to the coal, and which forms, for some distance, the sides of the main haulage slope, affords an abundant supply of water, which for drinking purposes is excellent, being cold, clear, and very pure. The mine pumps are kept constantly at work discharging water from the mine. The sump, 33 ft. $\times$16 ft.$\times$6 ft. deep, is located at the bottom of the main slope.

The coal on leaving the mine is carried to the tipple, which is constructed of brick and concrete, reinforced with steel. Here, the coal goes over a series of screens, the lump coal traveling on a movable picking table and lowering boom to the railroad cars. The grades of coal are lump, nut, pea, and slack. In the near future, the coal is to be further separated by passing the finer coal over shaking screens, making from the nut, pea, and slack, a clean domestic nut, and a coarse slack.

The town of Glouster, on the edge of which is the Hisylvania No. 22 mine, has a population of somewhat over 3,000; five churches which are well attended; one high school built of brick, and two grammar schools. The streets, as shown in Fig. 3, are paved with brick, and lighted by electric lights. There is a good system of waterworks and sewerage.

For the information and illustrations contained in this article relative to the Hisylvania No. 22 mine, the writer is indebted to J. W. Blower, president of the Hisylvania Coal Co., and to E. M. Blower, director.

Use of Naphthalene in Coal Briquets

*By Bergassessor Grahn**

To reduce the consumption of tar when making briquets, several coal mines in the Rhenish-Westphalian district have been using naphthalene as an agglomerating substance.

By the Buzz-Fohr process the agglomeration of the coal was obtained by means of superheated steam and naphthalene, the steam being at a higher temperature than the boiling point for the naphthalene, that is to say, between 200 and 300 degrees. In fact, the temperature in the pug mill was about 220 degrees and the naphthalene, remaining liquid was imperfectly incorporated in the coal. If the coal was previously heated, the paste would reach the press at too high a temperature.

At the Gelsenkirchen mines the process has been improved in order to avoid this difficulty. The napthalene, previously heated by steam in a closed vessel in communication with compressed air, is raised to another vessel placed above the pug mill, and is sent regularly, by means of steam, through an injection pipe, under the form of a very fine rain on the mixture of coal and tar in the pug mill. The steam heated to 350 degrees introduced into the pug mill, makes it possible to maintain a temperature of about 250 degrees. If the temperature is too high, or the quantity of steam too great, little white clouds of naphthalene are immediately formed above the apparatus, and by this indication the steam is regulated. The mixture of coal, naphthalene, and tar is then taken to the press by means of a screw conveyer. The briquets thus obtained, when cold, are harder than the ordinary briquets. With the addition of .2 per cent. of naphthalene, a saving of 1 per cent. of tar is realized. It is said that the saving would be 2 per cent. of tar for .3 per cent. of naphthalene.

In the Schuring process the naphthalene previously heated, is vaporized in an apparatus heated with steam, and then injected, in a gaseous state, into the mixture of coal and tar, by means of a jet of superheated steam.

This process was tried with success at the Hansa experimental station of the Norddeutscher-Lloyd, at Bremerhaven, and at the Blankenburg mine in the district of Dortmund. The results furnished by the management of the Blankenburg mine are:

For a mine affiliated with the Syndicate, 1 ton of tar costs 30 marks, 1 ton of naphthalene 47 marks, and the saving realized per ton of briquets would be 48 pfennigs, or about 11 cents.

For a mine independent from the Syndicate, 1 ton of tar would cost 61 marks and 1 ton of naphthalene 47 marks, and the saving realized would reach 85 pfennigs, or about 20 cents per ton.

It is necessary not to exceed .3 per cent. of naphthalene, for a larger quantity would cause the paste for briquets to adhere to the compartments of the press and the briquets would break when coming out of the mold.

In the last 3 years the excavation incident to the mining of coal in West Virginia has been greater than the excavation required in eleven years to dig the Panama Canal.—*P. & B.*

*Professor at the Mining School of Bochum. Translated from *Glückauf*.

Uniformity in Inspectors' Reports

Advantages That Would Result if Reports of the State Mine Inspectors Covered Uniform Years and Similar Statistics

By Rufus J. Foster

SOME years ago, both through the editorial columns of The Colliery Engineer, and in personal conversation with numerous state mine inspectors, the writer strongly urged a convention of mine inspectors to consider, and, if possible, formulate plans to bring about uniformity in state mine inspectors' reports

Later, a subordinate, with the writer's full consent and hearty approbation, took an active part in organizing the Mine Inspectors' Institute of the United States of America.

When this organization was formed, many men interested in coal mining felt that it would not only prove a useful organization, as it has in many ways, but it would be a medium through which the idea of uniformity could ultimately be accomplished. The institute has now been in existence several years and has considered a number of important subjects connected with coal mining. As its meetings are held but once a year, and the number of questions to be discussed is large and time available short, it is not surprising that the subject of uniformity in reports has not been taken up.

The next meeting of the institute will be held in June. Therefore it is not too early for the members to give this subject careful consideration. Mine officials, and, in fact, all engaged in coal mining in the United States should also take an interest in the matter, and through suggestions and moral support help the work along.

To get the opinion of the state mine inspectors on the subject, I recently wrote to every inspector in the country, regardless of whether he was a member of the Institute or not. I have received replies from nearly all of them, and in every case the idea of uniformity in reports was indorsed. In some instances inspectors went beyond my request for a mere expression of opinion on the subject, and gave assurance that they not only believed the idea one of great value, but that they would individually support the movement by personal work.

Uniformity in reports, as I advocate it, means both uniformity in statistical tables and in the fiscal year. By such uniformity, and a uniformity in designating exactly what constitutes a fatal accident, inspectors and every one else interested can make comparisons as to conditions in various states and in the several districts of the states.

Such comparisons will lead to a study of conditions under which exceptionally good results are obtained, and the methods by which such results are achieved. This will naturally mean the adoption or adaptation of methods that have proved best, and the discarding of poorer or less safe methods of mining. It will tend to increasing safety, lessening cost of mining, conservation of coal, and in many cases to profit to the mine owner instead of loss.

It will also result in an opportunity to study the effect of the legislation affecting coal mining in the various states, and ultimately in more uniformity in such legislation.

As an evidence of the desirability of uniformity in the reports, I quote the following extracts from some of the many letters received:

Mr. Earl A. Henry, Chief of Department of Mines of West Virginia, says:

"It would certainly be the best thing I know of if all the annual reports of the various mining departments in the United States were made uniform, particularly in the statistical tables, but the present mining laws in some states prohibit this.

"For instance—the mine laws of Ohio prohibit the publication in the annual reports of the tonnage produced by each mine—in other words the tonnage can only be shown as the total production of each county. In West Virginia (as in Pennsylvania, and a number of other states) we show the tonnage produced by each mine, and other information which cannot be shown in some other reports on account of prohibitive laws, but I hope that through the Mine Inspectors' Institute and other influences, we will be able to have uniformity in the reports of the mining departments of all states. It will certainly be a great convenience to, and will furnish valuable information to everybody interested."

Mr. C. J. Norwood, Chief Inspector of Mines of Kentucky, says:

"I think you are entirely correct as to uniformity with respect to the period covered by mining statistics. At one time the fiscal year in Kentucky ended June 30, but this was changed by law in 1892, and since that time our statistical reports have covered the calendar year. As to having uniformity in the tables showing the various statistics, I am not sure that that would be practicable, without changes in the mine laws of some states. Such uniformity will largely depend upon what statistics the inspectors are in position to collect. Unless coal operators are definitely required by law to report statistics covering various matters, it will be impossible to gather complete statistics covering each question. Some operators will give prompt and full replies to every question, while others will reply only to those questions, the answers to which are required by law. I think the chief thing to be desired is uniformity in the periods covered by the statistics."

Mr. R. T. Rhys, Inspector of District No. 2, Iowa, in a lengthy, analytical opinion, heartily favors uniformity. In brief he says: "The

necessity for uniformity in compiling coal mining statistics throughout our mining states is apparent to every person who wishes to readily acquire correct data. Natural conditions and local customs may make the adoption of uniform legislation upon many things impracticable, but I know of no good reason why the statistics of all coal mines throughout the country cannot be compiled in uniform manner. The first thing necessary to bring this desirable object to pass, is the adoption of a uniform fiscal year. I favor the calendar year. It is the most natural division of time, will cause least confusion and error, and is the one most commonly used in the business world. In order to adopt the calendar year, it will be necessary to change the laws in some states. Such is the case in Iowa. At present our fiscal year ends June 30. In the early history of mining the need of uniformity was not as obvious as it is today. Until recent years the coal operators of Iowa were required to make but few simple reports to one or two state departments. Now, they are required to make out many minute reports to several state and national departments or bureaus. Some require reports for the calendar year, and others for the fiscal year. This lack of uniformity causes much additional clerical work, and considerable confusion. This confusion is not due to inaccuracy in reports, but is due to their being compiled for different periods. In order to remedy this, the State Mine Inspection Department of Iowa, will recommend to the next General Assembly the adoption of the calendar year for all mine statistics of the state."

Besides uniformity of time for mine statistics, there should be a more uniform application of some of our statistical items, such as "Fatal Accident," "Serious Accident," and "Minor Accident." The term "Fatal Accident" is not applied alike in all states. If the person injured does not die from the effects of the injury within a certain length of time, the accident is not counted as a "Fatal" one. This certain length of time varies in different states. Similar variance exists in regard to "Serious" and "Minor" accidents.

Mr. W. E. Jones, State Mine Inspector, District No. 2, of Wyoming, says: "I am in hearty accord with the idea of uniformity in the matter of statistics. The law in this state requires the mine inspectors to have their reports in the Governor's hands by December 5, for the year ending September 30. The legislature convenes in January, biennially, and the only objection that could be raised in this state, against the reports covering the calendar year would be the impossibility of the production of a complete report by the time the legislature convenes. This objection, however, can be overcome by submitting a special report covering recommendations and essential statistics to the members of the legislature, pending the printing of the entire report. There should also be uniformity in the methods of calculating the percentages of fatalities and injuries."

Mr. James E. Roderick, Chief of the Department of Mines of Pennsylvania, speaking for himself and his twenty-one anthracite and twenty-eight bituminous mine inspectors, says:

"In reply to your inquiry regarding uniformity in state mine inspectors' reports, I would say I am heartily in favor of it, both as to arrangement of statistics and as to uniformity in fiscal years.

"The scheme for the statistical tables used in the Annual Reports of the Pennsylvania Department of Mines, was worked out by me after many years of experience, and is now as nearly perfect as I can make it. If in an effort to attain uniformity, any practical improvements can be suggested, I will be glad to incorporate them in our plan. The statistical tables in the Pennsylvania reports are very complete, and possibly go into greater detail than will be practical in all states, at first, but I think our general form will be a good basis on which to build uniform tables, even if for a time, those of some states should not contain all the details ours do."

To quote from all the letters received on this subject would simply be a repetition of statements made by the gentlemen already quoted, therefore I have not thought it necessary to quote from all.

Mr. Roderick's reference to the shape in which the statistical tables appear in the reports of the Pennsylvania mine inspectors is warranted by their completeness. By this statement I do not want to be understood as reflecting on the mining departments of other states. Many of them issue reports of a commendable character, but Pennsylvania, being the greatest coal producer, and being the first state to establish a system of state mine inspection, has, through many years of experience, developed a system of statistics which is almost perfect. The statistics given are for the calendar year and are in great detail. Any man interested in mining can readily compare the statistics of any one Pennsylvania district with those of another, regardless of the nature of the coal mined. Naturally, in making such comparisons he must take into consideration local conditions as to the nature of the coal, its composition and its gaseous or nongaseous nature.

The thoughtful or studious mine official learns a great deal of value from such comparisons. He learns to avoid mistakes of others and to profit by good ideas of his colleagues in another field or district.

If all the coal mining states would arrange to have their inspectors' reports cover the calendar year, and the chief mine inspector would require that statistics be given in tables uniform with the excellently arranged tables used in Pennsylvania, a great step forward would be taken in the matter of safe and economic mining. Of course, the Pennsylvania statistical tables contain

more details than the heads of the inspection service of some states would consider necessary, and in some cases they contain less. This need not seriously affect the idea of uniformity. Columns could be taken from or added to the Pennsylvania forms to suit existing conditions.

If this uniformity is ever accomplished, it will enable mining men to readily compare similar items in various states, such as the number of mines, the number in operation, tonnage shipped to market, tonnage used at the mines, methods of working, fatalities per thousand employes, tonnage produced per fatality, causes of accidents, etc.

As conditions are, it is an almost hopeless task for a man in one state to find data he desires from the mine inspector's report of some other state.

If the Mine Inspectors' Institute will take up this question of uniformity in reports it will be a potent factor in accomplishing such a desired end; and, there is no doubt that every progressive mine official will give the movement both moral and personal support.

Burning Low-Grade Anthracite

*By J. E. Parrish**

At the present time all anthracite coal passing over a $\frac{1}{16}$-inch mesh screen is considered salable.

This has been made possible by improvement in boiler design, taking advantage of the air space in the grates, high ash pit pressures due to forced, balanced, and induced drafts, thus eliminating high and costly chimneys, save when city ordinances require them. By these conditions in boiler practice, even the mud, slush, and dust can, and will be burned. Eventually, all grades of coal will be mixed and pulverized, and automatically fed into furnaces for steam purposes.

In the early days of coal mining in the anthracite region, the smallest size of coal prepared for market was what is termed chestnut coal. There was a time when egg, stove, broken and lump were the prepared sizes, all railroads and factories using lump coal entirely, chestnut going to the culm pile with the waste products. The general idea at that time being the larger the coal, the more carbon it contained.

However, at that time, boilers were not designed for anything but those sizes. It was but a few years ago that consumers realized that there was as much carbon in the small sizes of coal as in the large ones. The coal operators then decided that the waste must stop and boilers and grates were designed to burn chestnut and pea coal. This was considered good enough for a few years, but knowing that the sizes smaller than pea coal contained just as much carbon, manufacturers of grate bars studied the problem of utilizing them. It was then that the mine owners conceived the plan of reclaiming the culm piles and extracting the chestnut, pea, and buckwheat coal.

Years ago when the plain cylinder or "log" boilers were used, they were built from 30 to 34 inches in diameter and from 30 to 50 feet long with a boiler rating of from 15 to 30 horsepower. Each boiler had from 10 to 20 square feet of grate area, the gases passing under the boiler to the base of the stack at the opposite end. Those who lived in

*Mechanical engineer, Scranton, Pa.

Picking Coal on Culm Piles that Accumulated in Early Days of Mining

Working Over Coal Piles for Washery

the vicinity of mines using these boilers will remember that, at night, flames could be seen coming out of the tops of 30- and 40-foot stacks, which showed a great waste of the heat units in the coal. Grates were stationary, with openings for the draft of from ½ to ¾ of an inch. The evaporative power of the boiler depended upon the natural draft of the stack; consequently, the large sizes of coal were used.

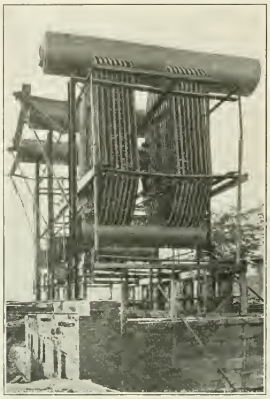
The locomotive type of boilers was used at some mines at that time, but they were but a small step in advancement as they, like the others, provided but one path of travel for the flames and hot gases.

The return-tubular boiler, or two-pass, boiler, the next step in improvement, was designed to give a rated horsepower with pea coal as fuel. There are many of these boilers in use both in mines and factories, and these can be changed and improved at a trifling expense to give more than their rated horsepower with buckwheat, barley, and rice coal as fuel. For instance, a return-tubular boiler 72 inches in diameter by 18 feet long with grates designed for pea coal, and with natural draft, would give 150 horsepower. That same boiler with redesigned furnace and grates and with forced draft, can, with buckwheat, barley, or rice coal, produce more than 150 horsepower.

The next step forward was the introduction of the water-tube boiler, constructed so that the hot gases from the fire travel three and four passes over the heating surfaces of the boiler before going into the stack, and designers have planned to take advantage of every available heat unit.

All builders of water-tube boilers strive to design boilers that will furnish the highest efficiency possible with the lowest and cheapest grades of coal as fuel, considering carefully the kind of grates to be used with forced, induced, and balanced drafts.

Five years ago, grates with 25 to 35 per cent. air space, having a ratio of 1 square foot of grate surface to 30 or 40 square feet of heating surface, with forced draft and from one-half to 1 inch water gauge in the ash pit, were considered good practice for anthracite. Today, grates are being used with 5 per cent. air space, having a ratio of 1 square foot of



Modern Boilers Being Installed at Coal Mine

grate surface to 15 to 25 square feet of heating surface and with a forced draft of 3 to 5 inches water gauge in the ash pit. Low-grade fuels require more grate area and higher forced draft, whether return-tubular or water-tube boilers are adopted. With such fuel a high chimney for natural draft is practically useless and good results can be obtained only by the use of forced draft.

In the use of this high air pressure in the ash pits, and through the grates, the fine fuel will be blown from the grates; however, with a brick arch over the grates to radiate an intense heat and with the balanced-draft system, the fine fuel from the grates is burned in suspension.

The object of the balanced-draft system is to hold back the gases in the furnace and combustion chamber, maintain a higher temperature, and produce more rapid and complete combustion, for, it is well known, that to produce the best efficiency combustion must be rapid and at a high heat. The old practice of filling the furnace full of coal and letting it burn slowly, was a good one for the coal agents, but very inefficient. Now it is fire light, and fire often.

With all the details in proper proportion, the finer the coal the more rapid will be the combustion, the more heat units there will be in the gases, the more efficient will be the boiler, and the more economy in operation will result.

The time is not far distant when fuel for steam purposes will be pulverized; the poorest coal, the boney coal and the slate all crushed and mixed, using by this process every pound of waste, also the mud and slush that are left from the culm piles. The pulverized fuel will be blown into the furnaces by steam or preheated air.

Another essential point is that the air for forced draft must be heated before being admitted to the ash pit, this will take heat units but it conserves coal energy. The air can be heated by the gases after they have done their work in the combustion chamber and are on the way to the stack.

In the line of stokers for these conditions, one is being worked out now by which the cheaper coal is pulverized by an attached crusher, and the pulverized coal and dust fed into the furnace.

It can be truthfully stated that, with the present improvements in boilers and furnaces, and with the improvements to come, there are no waste products in anthracite. Culm piles, the accumulation of years in early wasteful mining, will soon be gone, the mud and slush used for fuel, for the modern boiler furnaces will burn anything capable of ignition. The modern coal breaker will then yield a return for every ton brought from the mines in the following proportions:

Chestnut and above, 68 per cent.; pea, 12 per cent.; buckwheat, 15 per cent.; barley, rice, and dust, 5 per cent. Total, 100 per cent.

The Bituminous Coal Industry and the Sherman Law

*By Charles M. Moderwell**

Considering the welfare of the human race, laws or economic systems which result in the waste of our coal supply are wrong in principle, and cannot be defended; and yet such theories and laws are accepted in the United States in the twentieth century.

I speak today in behalf of the bituminous coal industry. This great industry, which produces the cheapest fuel in the world for the factories of the United States, is suffering because those engaged in it are not allowed to "cooperate," but must compete." The result is, that with an investment of almost a billion dollars and an annual production of 500,000,000 tons, the average return on the investment is only 2½ per cent. annually.

With a knowledge of such conditions it is not surprising to hear that the bituminous coal mining industry of this country is not conducted so as to best conserve the coal deposits. Because of inability to get a sufficient price for the product, only the easily mined coal is being removed in some places, the remainder being left in the mines. This coal, in most cases, will never be recovered, or if recovered, it will be at a tremendous cost.

In Bulletin 47 of the United States Bureau of Mines, Dr. J. A. Holmes, Director of the Bureau, states:

"During the past year (1911) in producing 500,000,000 tons of coal we wasted or left underground in such a condition that it will probably not be recovered in the future, 250,000,000 tons of coal. In a higher way, our mineral resources should be regarded as property to be held in trust with regard to both the present and future needs of the country. Neither human labor nor human agency has contributed to their intrinsic value and whatever rights the individual may possess have been derived from the general government. The government does not surrender its right, and should not neglect its duty to safeguard the welfare of its future citizens by preventing the waste of these resources."*

Admitting the duty of the government to safeguard the coal deposits and to prevent waste, does it not follow that the government should permit such cooperation under regulation, as will permit the coal operators to obtain a price for their product which in turn will permit them to save for future generations the coal now so ruthlessly wasted?

The industry for which I am speaking is one in which the public has, or should have, an interest. Next to agriculture it is the most important of all. It employs more than three-quarters of a million men; furnishes 65 per cent. of all the traffic for the railroads and has made possible the great industrial development of which we love to boast.

Intimately affecting, as it does, the lives and welfare of all our citizens, it should receive at the hands of our law makers, attention proportionate to its importance. And yet although approximately one-half the size of the agricultural industry, the United States spends only $\frac{1}{24}$ as much for the mining industry as for agriculture, to say nothing of the same relative expenditures by state governments.

Let me show by an actual example the effect of the Sherman Anti-Trust law and similar laws of the various states.

During a time of unusual prosperity, four coal mines were opened in a western state and engaged in interstate trade. Of these, two belonged to large companies owning mines in different parts of the West, one belonged to a man independently rich, and the fourth was the sole property of a man who invested in it the savings of a lifetime. For a few years all prospered. Then came the panic of 1907 and hard times followed. The demand for coal was less than the capacity of the four mines and the mines began to lose money. After enduring the loss for some time, representatives of the mines met to agree upon a limitation of output and to cease their cutthroat competition. Because they wished to avoid any offense against the law, they called in a lawyer to advise them. The lawyer told them that to agree to apportion the territory supplied by these mines among the different producers, or to agree upon the output of each mine, would be illegal, and would subject them to jail sentences. He gave his opinion that the four mines could be merged into one company without violating the law, but none of the mines wished to do this. The mines owned by the large companies were covered by bond issues. The rich mine owner was able but not willing to sell. The poor mine owner acted as his own manager and could not afford to give up his salary. The four mines are still competing. No doubt the users of coal receive the benefit from this competition while it lasts, but it cannot last long. The companies are able to operate one mine at a loss during this enforced commercial war; the rich mine owner is suffering and the poor mine owner is being ground out of existence. When this takes place, the survivors will have a legal monopoly of the market and will hope to recoup their losses by raising the price of coal.

The example given above raises one of the fundamental problems of the "trust question." Does the public welfare demand that individuals shall be destroyed and monopoly created in the name of competition? Or is it better under such circumstances as are outlined, that the Trade Commission shall be allowed to say whether or not an agreement such as the above mine owners attempted to make is in restraint of trade, or whether it is or not; whether it seems to be in the inter-

*Address delivered before the National Civic Federation, Hotel Astor, New York City, December 12, 1913.

*This statement is a guess and is not anywhere near correct.—Editor.

est of justice and the public welfare. Do you wonder that the bituminous coal operators of the United States are seeking relief from conditions such as described? We are not seeking a monopoly, and by reason of the vast area of the coal deposits, could not secure a monopoly if we would; but are asking for the right to make such agreements among ourselves, under regulations that will save to future generations the coal now lost and at the same time permit the earning of a reasonable return on the capital invested. More than 40 years before the passage of the Sherman law the English Parliament repealed all laws against such trade agreements as were not monopolies or contrary to public policy. Of all the commercial nations of the world, in the United States alone does this anomalous situation exist. In Germany and France the people encourage the syndicates which control the mining and sale of coal and the manufacture and sale of other commodities.

Your organization, through its committees, has made a study of the workings of the so-called "Sherman Anti-Trust Law." Similar committees of the American Mining Congress have made a study of the law, with the result that they have prepared a bill which is, in effect, a modification of the Sherman law. We believe that the bill in question is based upon sound principles and not only is not inimical to the interests of the American public, but that those interests will be best served through the enactment of some such legislation as this bill provides.

Briefly, the bill calls for an Interstate Trade Commission, having powers and duties similar to those of the Interstate Commerce Commission, but with jurisdiction over industrial corporations only. This commission would have power to inquire into all kinds of agreements, contracts, etc., and to determine whether they are in violation of the Sherman Act and whether they unlawfully restrict trade or tend to monopoly. Under this bill, any corporation or individual, may submit to the Commission, for its approval, any agreement it desires to make and the Commission's approval of this agreement is to be final and conclusive as to all questions of fact, and also conclusive that such agreement is not in violation of the Sherman Act and an unlawful restraint of trade.

Without going into further detail, the Interstate Commerce Commission bill of the American Mining Congress is designed to permit business men to conduct their business in accordance with economic principles and yet live within the law. Is it too much to ask of the American public, as represented by their law makers, that the business world be granted this right?

Coal and Coke Section of A. I. M. E

Dr. H. M. Chance, Chairman, and E. T. Conner, Secretary, of the Coal and Coke Committee of the American Institute of Mining Engineers, mailed circulars and letters to 107 members of the Institute announcing its action in partitioning the United States and Canada into districts, one of which was assigned to a member, requesting him to send the Committee a list of those engaged in mining coal or making coke, who would be desirable members of the Institute. The total names of prospective members, received from 39 of the 107 is 876, and the secretary would be pleased to hear from the 58 others.

To advance the coal mining industry there must be cooperation, and this can only be accomplished by concerted action and after due deliberation.

To keep posted on coal mining and its preparation, one must belong to the American Institute of Mining Engineers and take The Colliery Engineer. The writer is deeply interested in both these matters, and will be pleased to recommend all those eligible and who meet the requirements for membership.

Flooded Coal Mine In Illinois

*By Frank Rosbottom, Inspector**

The mine of the Gallatin Coal and Coke Co., at Equality, Ill., was completely destroyed by the floods in April, 1913.

This mine is one of the old operations opened by shaft in 1882. It has never been operated on a large scale, and altogether there have been taken out a little more than 200 acres of coal of the No. 5 seam, which is about 5 feet thick at this place.

The opening to this mine, which is a shaft 90 feet deep, was on the Louisville & Nashville Railroad, just at the west corporate line of the city of Equality, and about 1,000 feet from the Saline River.

On driving the opening entries of the mine it was found that apparently the coal went to the outcrop to the east, and as the river was on the north it was not thought advisable to work in that direction; consequently the mine was all worked from one side, namely, the north, with cross-entries leading to the east and west entries. The works extended north about 1 mile and were about a half mile in extent east and west at the greatest distance.

The level of the mouth of the shaft was about 1 foot above the 1884 flood, which was the greatest ever known in this part of the state, and which it was thought would never be equaled again.

About March 28, 1913, it was pretty well known that all previous water records would be broken here, so they began to make efforts to protect the mine. They had a large crew of men dig trenches down to the clay and fill them with moist clay, tamping it in. Above the level of the surface they had a heavy timber retaining wall built on either side of this trench 6 feet apart, filling in between with clay and tamping it in. By April 1 the mine was surrounded by water and it became necessary to boat all material

*Inspector, 11th District, Illinois Coal Report, 1913.

for the building of these levees a distance of several hundred feet.

April 2 the cribbing in the shaft gave way on the east side at a point about 20 feet below the surface, letting in considerable water and carrying away a part of the levee. They made renewed efforts and, with the assistance of the citizens who turned out almost to a man and did splendid work, they succeeded in getting this break stopped. On the morning of April 3, the cribbing in the shaft, which was old, gave way on the west side just above the rock, which is about 28 feet below the surface. This caused what had been an old slip to give way, taking into the shaft the levee on this side and with it the surface to a distance of 10 or 12 feet west of the mouth of the shaft. Again everybody responded, and again after untiring and heroic efforts on the part of the entire citizenship, they succeeded in stopping this break. It seemed for the next 2 days that the only effort needed was to keep their dykes above the rise of the water, which was a very difficult task now on account of their being more than 300 feet long, and having to handle all material in small boats. They secured bags of sand and succeeded in keeping above the water by dint of great effort. Sunday morning, April 6, when the water was almost at its greatest height, they began to feel that they could and would succeed in keeping it out, when it was discovered that a very small stream was running in through the clay from the south side at a depth of possibly 10 feet below the surface of the water. They began strengthening the dykes on this side with sand bags, but before a great while they could see that this little stream was increasing in size. It steadily grew larger until at 9:28 A. M., with a mighty inrush of what looked like the entire river, the water broke through under the levee, carrying it and everything for a hundred yards around into the shaft. The velocity of the water was so great that it carried pit cars and other objects that were near the pit head into the mine, and the suction pulled the end out of the engine and boiler room and blacksmith shop.

In 1 hour and 22 minutes after the water had begun running into the mine it completely filled the shaft, thereby trapping the air that was in the mine. The mine goes to the dip in all directions, being 13 feet lower at the air-shaft than at the hoisting shaft and 48 feet lower in some of the northeast entries than at the main shaft. After the water had filled the opening at the main shaft and had filled the mine until the air could not escape at the air-shaft, it continued to run in for 5 hours, all the time compressing the air that was behind it and trapping in more as the pressure and weight of water increased. At 3:50 in the afternoon of the 6th, after the water had been compressing the air for 5 hours, the air rebounded with a force that was almost beyond comprehension. It threw out mine cars, cages, huge concrete blocks, sheave wheels, engines, and completely destroyed the entire top works. Water, stone, dirt, and machinery were thrown into the air to an estimated height of 500 feet. The sheave wheels, which had gone down the shaft together with the head-frame, were blown out and fell over a hundred yards from the pit head, completely burying themselves in the hard earth.

Twenty-two minutes after the first outburst, a second one came, and 8 minutes after, was followed by a third, either of which showed considerably less force than the first. The second outburst threw water to a height of possibly 150 feet, and a picture was made of it while in action by one of the local photographers. The third outburst, which rose to a height of probably 75 feet, was followed by numerous others each in turn growing less and less until they were only huge air bubbles. This bubbling continued for more than a week before the mine finally filled. The water in the shaft now stands to within 2 feet of the level of the surface and presents the appearance of an old well caved in around the top until it is about 40 feet across.

Telepathy in Rescue Work

On Monday, February 16, Andrew Chernik, and Mike Babsanki, two miners in the Cannon coal mine, Franklin County, Wash., drove a chute so close to the surface that the overlying gravel and water rushed down the chute and buried them. Rescue parties began work immediately and on Thursday, 4 days after the accident, the body of Andrew Chernik was found in the mass of gravel and boulders. The work of rescuing was extremely hazardous and when Chernik's body was found it was supposed that his partner, too, had been killed.

However, under the direction of General Superintendent William Hann, and the resident superintendent, Walter Warnock, the rescue work was carried on in short shifts by volunteers only. The work was so dangerous that only those who offered to go were allowed to work. Day after day they labored to recover what they thought would be the dead body of Babsanki. They finally gave up trying in one direction, and began working in another part of the chute.

The supposed widow went Saturday to Black Diamond, a neighboring town to buy mourning, and on entering the store, had a strange premonition that her husband was not dead. She went to the mine and prevailed on the men to try once more at the place they had started first and had left. In a comparatively short time they reached the imprisoned miner and found him alive in a vault-like opening, in the mass of timber, gravel and boulders. The space he had been carried into was about 18 inches high, 4 feet wide, and 10 feet long. He managed to get water from the drippers, and there was sufficient air leaking to supply him.

When reached, Babsanki was very

weak, but after careful treatment by the rescue party and the mine physician he improved rapidly.

This is an object lesson for rescue parties. In this case death from being crushed in the mass of debris seemed a certainty. Further, the length of time, seven days, the miner had been entombed would lead one to believe that he had either smothered or starved to death. This is an instance in which apparently all hope had gone, yet in the face of this handicap and extreme danger, the rescue work was continued and a wife and children today have their breadwinner, where if less persistent mine officials had been in charge, the result might have been different.

OBITUARY

JOHN E. WATERS

John E. Waters, for 34 years superintendent of the Wheeling Creek mine of the Lorain Coal and Dock Co., died at his residence in Bridgeport, Ohio, on March 4.

Mr. Waters was born in Pottsville, Pa., on September 29, 1847. At the early age of fourteen he enlisted in the Union army as a drummer boy. He was captured by the Confederates and was confined in Libby prison for 9 months. At the close of the war he took up practical civil and mining engineering as a chainman on a corps, and through natural ability soon became proficient in coal mining engineering. During this time he became interested in athletics and became noted as an amateur cricketer and baseball player.

In the seventies he left Pottsville to engage in bituminous coal mining and in 1880 he accepted the position he held until the time of his death. Under his supervision, the Wheeling Creek mine became one of the largest producers in Ohio.

During his long residence in Bridgeport he became one of the best known coal men in eastern Ohio, and one of the most prominent citizens of Belmont County. He was a member of the various Masonic bodies, up to and including the Knights Templar, and was a member of Osiris Temple, A. A. O. N. M. S.

In 1872 he was married to Miss Carrie B. Dobson, of Pottsville, Pa., who, with two children, Oliver D. Waters, of Bridgeport, Ohio, and Mrs. Grace P. Robinson, of Norfolk, Va., survive him.

His remains were interred in the Chas. Baber Cemetery at Pottsville, Pa., on March 7.

GEORGE PATTERSON

George Patterson, at one time prominent as a mining engineer and mine manager, and later prominently identified with the manufacture of mining explosives, died at Wilmington, Del., on March 13.

Mr. Patterson was a native of Pottsville, Pa., and was born on February 24, 1854. He came of a family that was very prominent in the development of the Schuylkill coal fields, and in early life he was identified with the engineering department of the Philadelphia & Reading Coal and Iron Co. He was in the employ of that company about 18 years, a large part of which time he was resident engineer successively, of the Minersville and Tremont districts.

He resigned from the latter position to accept the position of general superintendent and engineer for the Eureka Coal and Iron Co., near Birmingham, Ala. About 6 years later he accepted a position with the Laflin & Rand Powder Co., as general superintendent in the manufacturing end, and was located at Wayne, N. J. He remained with the Laflin & Rand Co. until its consolidation with the E. I. du Pont de Nemours Powder Co., in 1902, at which time he became general superintendent in charge of the black powder operations for all the mills of the consolidated company. This position he held until about 2 years ago, when on account of his health, he retired to his country place, Clearview, at Holly Oak, near Wilmington, Del.

While in the engineering department of the Philadelphia & Reading Coal and Iron Co., Mr. Patterson married Miss Nellie Geer, a daughter of the late Seth W. Geer, Esq., of Minersville, Pa., who, with several grown sons, survives him.

George Patterson was one of the rare characters who combined in his nature a strong personality with a most gentle and lovable disposition. He enjoyed a high reputation as an engineer and constructionist, and his executive ability, high sense of fairness, and even temperament, earned for him, not only the high regard of his associates and employers, but of all employed under him as well. During all his long experience with the du Pont company, directing the work of thousands of men, he never had a strike.

Coal Mining Comparatively Safe

Bulletin 69, of the United States Bureau of Mines shows that in 1911 the number of coal miners in this country was 729,279. Of this nummer 31,334 were injured more or less seriously. In the same year, according to the "Twenty-fifth Annual Report of the Interstate Commerce Commission," the railroads employed 1,669,809 and of this number 126,039 were injured. United States Senate Document 110, Sixty-Second Congress, bears testimony to the fact that 35,764 steel workers were injured of 158,604 employed.

A study of the figures contained in these government documents shows that there were about half as many coal miners as railroad men employed and that less than one-fourth as many were injured.

It is also shown that, while the mines employed 570,675 more men than the steel mills, the steel mills injured 4,430 more men than the mines did.

A reduction of the figures to a common basis brings out the fact that, for each thousand men employed, 42.96 were hurt in the coal mines, 75.48 on the railroads and 225.48 in the steel mills.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Correction

In the March issue relative to the solution finding the capacity of a mine car, use the prismoidal formula $V=\frac{H}{6}(B+b+4M)$, instead of the one used. M=area of cross-section, midway between and parallel to the two parallel sides. This will make the result 63.2 bushels instead of 60.3.

The Prevention of Accidents

Editor The Colliery Engineer:

Sir:—Those who read the Bituminous Mine Inspectors' reports carefully are convinced that the responsibility for preventable accidents falls on the employes and mine officials alike. The improvement of late in regard to fatalities is in a measure due to the companies following articles 6 and 8 of the Pennsylvania law of 1911.

A good piece of machinery is more easily obtained than a good superintendent or foreman, for these men can only be obtained by paying salaries commensurate with their intelligence. The increased responsibilities placed on mine officials by the 1911 Bituminous mine laws requires intelligence of a high order and employers might encourage their officials not to be content with a certificate of competency, but to strive for more knowledge of things pertaining to mining. The more ignorant the miner, the more thoughtless he is, therefore he should attend miners' institutes or the company schools now established.

The mine official who will once in a while take time to show men how he would do things rather than say "Do things as I demand," will educate his men and be thought more of as a human being. Men working for the same company have the same interests in common and all should work for their mutual benefit and strive to learn and to avoid accidents that reflect on each other. Hurry and confusion go with poor management and invariably lead to accidents, while order and safety generally go together. Failure to make repairs when needed is a prolific source of accidents. The mine official must have a quick eye to detect such matters, and as he cannot be everywhere at one time he should encourage his men to report anything unusual and dangerous. We have heard mine officials growl at men who reported things they considered dangerous when they should have complimented.

Neither personal talent nor energy will compensate for the want of discipline. *Rules and laws must be obeyed.* Kindness and firmness must go hand in hand, and the person who cannot appreciate why this should be so, needs quick discharge. Young men are more susceptible to explanations than middle-aged and old men, but all will listen to a mine official whom they respect, therefore take time to explain why you must have discipline, otherwise they assume that you are theoretical and imagining things.

Article 4, 1911 law, should be taken up section by section by the superintendent and foreman in order to get a clear understanding of each other's responsibilities. Then the duties of the fire boss should be discussed by the three. The laws must be followed but if the purpose of the law is lacking it should be explained. The men are next to be told their duties, and why the general rules were placed in the law.

It is foolishness for men to complain of operators and mine officials to inspectors when they will not protect themselves. If men will continue to load coal under a dangerous roof, or fail to set sprags under loose coal, carry matches in gaseous mines, tamper with a safety lamp, overload the shot holes, shoot off the solid, and do many other matters that jeopardize their own and others lives, they have no right to complain of mismanagement, for they are living in glass houses. In spite of all precautions, accidents will happen, therefore none can be too careful. Married men should remember their families' dependence on them, single men should remember their parents, and the children of other miners, and thus mutually aid each other. Study the rules and regulations in the 1911 law, also the bosses' duties.

Chas. P. McGregor, Inspector
Grafton, Pa.

Rescue Work Instruction

Editor The Colliery Engineer:

Sir:—Car No. 7, of the United States Bureau of Mines has recently been located at Mora, W. Va. Under the able instruction of Messrs. Jesse Henson and A. W. Harris, mining engineers, teams from the surrounding mines have been taking daily practice in mine rescue and first aid to injured. The team from the American Coal Co.'s Crane Creek mine made excellent progress, and has been recommended to the Bureau of Mines for first-grade certificates in mine rescue and first-aid work. The successful candidates are: Peter Drinnan, G. E. Wysor, R. G. Bailey, Mack Hurst, N. B. Mangus.

Some months ago, G. E. Wysor, former instructor in first aid in the hospital service of the United States army, organized a class at this place for the study of first-aid work. The class has steadily grown in number

and interest. At the suggestion of Messrs. Henson and Harris, the class resolved itself into a mining institute, and will study the various phases of practical mining, mine rescue, and first aid.

Manning, W. Va. P. D.

Stone Dusting in Dusty Coal Mines

Editor The Colliery Engineer:

Sir:—Stone dusting has aroused worldwide interest, as is demonstrated by the articles written for mining societies and mining journals.

Recently Mr. Samuel Dean, of Delagua, Colo., contributed a paper to the North of England Institute of Mining and Mechanical Engineers, in which he particularly took up the question of the treatment of coal dust. This has been followed by a paper to the same society on the "Automatic Distribution of Stone Dust by the Air-Currents," written by Mr. H. W. G. Halbaum.

There are two recognized possible dangers in all dusty mines which undoubtedly have received and are receiving the anxious consideration of the general staff of such mines, viz., the use of electric haulage, and blasting.

A large number of coal mines in the United States use electric haulage, it being a convenient mode of traction, easily established. The greatest danger from the use of electricity appears to be due to arcs, sparking, and fugitive electric currents. Attention was called to the latter subject in The Colliery Engineer, Vol. 33, page 356, and was pooh-poohed by some leading electrical authorities.

The danger from the use of electric power would appear to be the greatest, so far as firedamp is concerned, from the spark between the overhead live wire and the end of the trolley arm; and in the case of coal dust, between the locomotive wheels and the rails of the haulage road.

Stone dusting may help to safeguard the coal-dust danger, but not the firedamp danger, and therefore the latter must depend entirely on the ventilating air-current. Here another difficulty arises which is that in a few mines in the United States the main haulage roads are the return air roads, and especially is this the case in coal mines in cold mountainous country. Every one who is conversant with these conditions must have noticed that the dampness of this air, which is often saturated with moisture, tends to cause the deposition of coal dust and that the air is noticeably free from clouds of dust even when the loaded trips are passing at a high velocity. Therefore, this is an important point when considering coal-dust dangers, but the use of the return airways as main haulage roads is, by Act of Parliament, rendered impossible in Grear Britain, and therefore the haulage ways in that country have the coldest and driest air of any part of the mine. In mines subject to outbursts of explosive gas it would of course be unsafe to apply electric haulage on roads used as return airways.

Mr. Dean failed to agree with Mr. Rice, who said that electric trolley locomotives added new coal-dust dangers. Mr. Dean argued that it was easy to treat a locomotive haulage road with stone dust so that in the event of a wreck large volumes of stone dust would be raised, and would neutralize the coal dust. Thus ignition would be prevented, notwithstanding that there might be an arc or other short circuiting of the electric current.

The recent explosion at the Dawson mine, in N. Mex., proved that good systems of watering were not to be relied on to localize an explosion, especially where there was a thoroughly brisk ventilating air-current.

Mr. W. W. Hood, of South Wales, after the Clydach Vale explosion, noticed while the exploring party were passing along a road which was about 800 yards long and naturally wet, that the timbers were absolutely wet, and yet had coked dust on them. This dust had been behind and on top of the timbers, and had not been reached by the water. He believes that this is a hidden danger which is not reached by either water or stone dust. He acknowledged that so small a quantity of coal dust as .023 ounce per foot of gallery would propagate an explosion. Further than that, experiments had proved that .78 ounce of coal dust per cubic foot of gallery was deposited in a South Wales colliery, where 1,000 tons of coal were hauled in 24 hours. Other mining engineers in South Wales hold that stone dusting must be accompanied by the sprinkling of the trips of loaded cars at the double partings.

It would appear to be necessary from the point of view of the stone dusting advocates, that in addition to the necessity of the stone dust being ground very fine, it must also be placed on shelves along the mine roadways if it is to be effective.

Mr. Halbaum in dealing with this matter concluded that the stone dust must be plentiful; it must be finely divided; it must be as buoyant as coal dust; it must reach the places where the coal dust reaches; its distribution must be as universal as the coal dust; and in conclusion that the stone dust must be distributed by the methods employed to distribute the coal dust, viz., by the air-current. This then results in the propositions that the cars used for the transportation of coal must be dust-tight and therefore without end doors, that they shall not be loaded more than level full, and that they be covered with a lid fitting inside the top of the car. At the partings a boy is to place a handful or two of stone dust or flue dust on each lid. Thus as the cars travel outby the dust is automatically blown off the cars, and reaches all the crevices where the coal dust is collecting, and becomes intimately mixed with it.

The greatest objection to this mode of procedure is that the output of the majority of collieries would be seriously reduced, especially in those cases where at least one-third of the load is piled up above the top of the car.

It would appear to be a natural sequence of safeguards, to reduce the velocity of the air-current in the main haulage roads and pass the main volume of air down the traveling way. This would certainly be healthier for the miners and would reduce one of the greatest and most serious dangers attached to the proposed use of stone dust as a safeguard against coal mine disasters; viz., the effect on the miners' lungs.

Experiments have been made with guinea pigs placed in a stone-dusted atmosphere to ascertain its effect on the lungs. This effect is said to be no more hurtful than coal dust, but the majority of people fear that it will cause an increase of phthisis, and be as harmful as the dust in the Rand gold mines of South Africa.

We know now that watering and spraying the roadways and adding steam to the intake air are inadequate to stop the flame of an explosion without the dust is made as wet as mud, and we also know something of the effect of silicious dust on the lungs, and thus we find that we are not nearer the goal of practical safety from explosions in coal mines.

The real point of safety seems to be lost sight of in the rush to find protection against the recklessness of generally one man, as in the Dawson, N. Mex., case; whereas the protection can be obtained in most cases by the abolition of blasting and more secure means of lighting the mines. Dangerous as is the use of high voltage electricity for hauling, pumping, and coal cutting, very few disasters can be traced to this cause, the only one which occurs to the writer being the Hulton colliery in England, where a coal cutter was being driven by an electric motor. There was also a supposed ignition of gas by a signal bell at a colliery in South Wales.

In conclusion, as we know that so small a quantity of coal dust as .023 ounce per cubic foot of roadway will propagate an explosion and that it is necessary to add more than an equal quantity of very fine stone dust to render it incapable of carrying flame it becomes clear that we are still a long way from being able to say that our coal mines are safe from great disasters.

James Ashworth

Notes on Mines and Mining

Large Coal Output.—The following coal output for one day, was made by the three mines of the Superior

Mine-Rescue Station Building, Pittsburg, Kan.

Coal Co., Gillespie, Ill. This company's general manager, John P. Reese, is president of the National Mine Safety Association, of Illinois, with headquarters at Pittsburg, Pa., and he has an able assistant in John H. Ross, the superintendent.

On March 9, 1914, the three mines hoisted 13,431 tons of coal in 8 hours, as follows: Mine No. 3, 4,608 tons; Mine No. 2, 4,429 tons; Mine No. 1, 4,394 tons. This represents a coal extraction of approximately 2 acres, the coal being of an average thickness of 8 feet.

This is a record run for No. 1 mine, but not for the other two, No. 3 having to its credit for an 8-hour shift, 4,748 tons.

The Saturday preceding (the 9th being Monday), the three mines produced 12,288 tons, and for the entire week ending Saturday, March 7, the total output of the three mines was 73,722 tons—a daily average of 12,287 tons. Monday afternoon, the 9th, No. 3 mine hoisted in 4 hours, 2,525 tons; equal to 631¼ tons per hour, or 5,050 tons per 8-hour day.

These shafts are 360 feet deep and have two hoisting compartments with single self-dumping cages; the cars hold about 2¾ tons each.

Kansas

A mine rescue station was established at Pittsburg, Kans., a few months ago by the government, and rescue car No. 4 has been detailed for duty there. The state appropriated $3,500 for the building. Structural work was started January 1, this year, and the building was completed, with the exception of finishing some of the rooms, by February 15. A spur of the Santa Fe railroad runs into the station, the building is only half a dozen blocks from the main part of Pittsburg, and in the very heart of the mining region. —*B. S.*

Pennsylvania

The Philadelphia & Reading Coal and Iron Co., issued an order effective March 1, limiting to 8 hours the time which a fire boss may work on one shift.

The duties of the fire bosses required long hours and the reduction of the time makes it necessary that additional men be employed. The new men will bear the title of inspector of mines.

Cost of Cylinder Oils

It is not a bull to declare that cylinder oils cost what is paid for them. Arthur Little says that operations which employ a chemist pay from 19 to 27 cents per gallon. Operations which do not employ a chemist or make use of a commercial chemist pay from 45 to 65 cents or possibly, if they "know their own business very well," $1.50 a gallon. There is probably not a large plant in the country in which, if it is not already under chemical control, the lubrication account cannot be cut in two. In the engine room of one large cement plant the average monthly cost for lubricants had been $337. It is now $30. A concern paying 37 cents a pound for a special grease which the superintendent needed to run the mill now buys on specification for 5½ cents, and the mill still runs. Another company within his knowledge saves $12,000 a year on cutting oils alone.

Answers to Examination Questions

Questions Selected From Those Asked at Examinations for Mine Manager, Mine Examiner, and Hoisting Engineer, in Illinois, and for First-Class and Second-Class Certificates in British Columbia

Ques. 1.—If a volume of 1,200 cubic feet of marsh gas is mixed with pure air in such a proportion that when exploded all the carbon in the marsh gas combines with the oxygen in the air, what volume of carbonic-acid gas will result, the carbonic-acid gas and the marsh gas being subjected to the same pressure and temperature? (B. C., first class)

Ans.—The equation for the reaction when marsh gas is burned in air, is

$$\underset{\text{I}}{CH_4}+2\underset{\text{II}}{(O-O)}=\underset{\text{I}}{CO_2}+2\underset{\text{II}}{H_2O}$$

The Roman numerals above the symbols for the gases denote the number of molecules. The equation may be read, one (I) molecule of marsh gas (CH_4) combines with two (II) molecules of oxygen (written O-O, since there are two atoms in the molecule) to form one (I) molecule of carbonic-acid gas (CO_2) and two (II) molecules of vapor of water (H_2O). Since the number of molecules and the volumes of gases involved in any chemical reaction are directly proportional to one another, it follows that one molecule or volume of CH_4 produces by its explosion one molecule or volume of CO_2 and that, consequently, 1,200 cubic feet of CH_4 will produce by its explosion, 1,200 cubic feet of CO_2.

Ques. 2.—If 30,000 cubic feet of air enter a shaft 14 feet in diameter, at a temperature of 60° F., what diameter of upcast is necessary to pass the same quantity, the velocity being the same in each case, and temperature of upcast 90° F.? (Ill., Mine Manager)

Ans.—The question presumably intends to ask what size upcast will be required to pass the original 30,000 cubic feet after it has been expanded through 30° (from 60° to 90°). Since the volumes are proportional to the absolute temperatures, and placing x equal to the volume at the higher temperature, we have x : 30,000 = (460 + 90) : (460 + 60), or x : 30,000 = 550 : 520. From this, $x=\frac{30{,}000\times550}{520}=31{,}731$ cubic feet, the pressure of the atmosphere remaining unchanged. The squares of the diameters of the downcast and upcast shafts will be proportional, respectively, to the quantities of air passing through them. Calling x the diameter of the upcast, $x^2 : 14^2 = 31{,}731 : 30{,}000$; whence $x^2 = \frac{196\times31{,}731}{30{,}000}=207.3092$. Extracting the square root, x = diameter of upcast = 14.40 feet, say 14 feet, 5 inches.

Ques. 3.—What is the weight of 650 cubic feet of marsh gas at a temperature of 60° F., the barometer being 29.5 inches? (B. C., first class)

Ans.—At a temperature of 32° F. and a barometric pressure of 30 inches, the specific gravity of marsh gas is .5576. As the weight of 1 cubic foot of air under these conditions is .08071 pound, we have the weight of 650 cubic feet of marsh gas at 32° F. and 30 inches pressure as 650 × .5576 × .08071 = 29.2525 pounds.

But the weight of a given volume of gas decreases as the pressure decreases and the absolute temperature increases. Calling w, t, and p, the known weight, and corresponding temperature and pressure, and W, T, and P, the unknown weight and its corresponding temperature and pressure, $\frac{W}{w}=\frac{p}{P}\times\frac{460+t}{460+T}=\frac{29.5}{30}\times\frac{460+32}{460+60}=.930$. From this, $W=w\times.930=29.2525\times.930=27.20$ pounds.

Ques. 4.—An entry is driven N 40° E, and the rooms are turned N 10° W, the pillars being 30 feet wide and the rooms 24 feet wide, what is the distance between room centers, measured on the entry? (Ill., Mine Manager)

Ans.—The distance between the centers of the rooms measured at right angles to their direction is 30 + 24 = 54 feet. The rooms make an angle of 10° + 40° = 50° with the entry. The problem is, then, to find the hypotenuse of a right-angled triangle when the base is 54 feet and the angle adjacent is 50 degrees.

$$\text{Hypotenuse}=\frac{\text{base}}{\sin\text{ adjacent angle}}=\frac{54}{.76604}=70.49\text{ feet}=\text{distance}$$

between room centers measured along the entry.

Ques. 5.—A room is driven 300 feet in length, 27 feet in width; the thickness of the coal seam is 3½ feet; how many tons of coal should the room yield, after deducting 10 per cent. for refuse, assuming that 1 cubic yard of coal weighs 1 long ton? (B. C., first class)

Ans.—Assuming that the room is the same width from mouth to face, the volume of coal in it is $\frac{300\times27\times3.5}{27}=1{,}050$ cubic yards. Deducting 10 per cent. for refuse, the net volume is $1{,}050-(1{,}050\times.10)=1{,}050-105=945$ cubic yards, which is also the tonnage of coal which the

room will yield, since 1 cubic yard weighs 1 long ton.

Ques. 6.—The indicated horsepower of a pumping engine raising 1,000 gallons of water per minute 500 feet vertically in a shaft is 200; what is the efficiency of the pump? (Ill., Mine Manager)

Ans.—Taking the weight of a gallon of water as 8.33 pounds, the horsepower necessary to raise 1,000 gallons per minute to a height of 500 feet, is, H. P. $= \frac{1{,}000 \times 8.33 \times 500}{33{,}000}$ $= 126.2$. As the indicated horsepower of the pumping engine is 200, the various losses in the system are $200 - 126.2 = 73.8$ H. P. The efficiency of the plant is $126.2 \div 200 = 63.1$ per cent.

Ques. 7.—If it requires 44 horsepower to drive the armature of a dynamo when it is delivering 29,820 watts, what is the efficiency of the dynamo under these conditions? (B. C., first class)

Ans.—44 horsepower is equal to $44 \times 746 = 32{,}824$ watts. Since the dynamo is delivering 29,820 watts and it requires the expenditure of the equivalent of 32,824 watts to drive it, the efficiency is $29{,}820 \div 32{,}824 = 90.9$, say 91 per cent.

Ques. 8.—What percentage of marsh gas in the air makes itself apparent in the safety lamp? (Ill., Mine Examiner)

Ans.—The percentage of methane which may be detected in mine air depends upon the lamp and oil used, upon the ability of the observer, and upon the presence of inert gases which tend to render the detection of the flame cap more difficult. Using the standard makes of safety lamp, the fire boss who can, with certainty, determine the existence of as little as 2 per cent. methane, is probably doing better than the average. Most men cannot do quite as well as this, although many claim to be able to detect as little as 1 per cent.

Ques. 9.—If 20,000 cubic feet of air and gas at its most explosive point are passing through the mine, what is the quantity of gas given off, and what quantity of air should be added to render it non-explosive? (B. C., second class)

Ans.—The mixture of marsh gas and air known as firedamp, is at its most explosive point when composed of 1 volume of gas to about 9.5 volumes of air. From this, for each volume of gas there is $1 + 9.5 = 10.5$ volumes of firedamp. Hence the amount of marsh gas in 20,000 cubic feet of the mixture is approximately, $\frac{1}{10.5} \times 20{,}000 = 1{,}905$ cubic feet.

When the proportion of gas to air is 1 : 13, the mixture ceases to be explosive. 1,905 cubic feet of gas will require $1{,}905 \times 13 = 24{,}765$ cubic feet of air to render it inert. The mixture already contains $20{,}000 - 1{,}905 = 18{,}095$ cubic feet of air; hence the amount to be added to render the mixture inert is $25{,}765 - 18{,}095 = 6{,}670$ cubic feet per minute. This is the minimum amount to be added.

Ques. 10.—We have a tank full of water in the morning when we commence work, we have no more water in sight, as the well is dry; the tank is circular 12 feet in diameter at the top, 14 feet at the bottom, and 18 feet deep. How long will we be able to run, using 1,200 horsepower per hour? (Ill., Mine Manager)

Ans.—It is first necessary to find the weight of water in the tank which is 18 feet deep and has an average diameter of $(12 + 14 \div 2 = 13$ feet. Assuming the weight of a cubic foot of water to be 62.5 pounds and since the volume of a cylinder is equal to the area of the cross-section (base) multiplied by the height, we will have, weight of water $= .7854\ d^2 \times h \times 62.5 = .7854 \times 13^2 \times 18 \times 62.5 = 149{,}334$ pounds.

It is commonly assumed that the development of each horsepower by the engines will require the evaporation of 35 pounds of water per hour at the boilers. From this, 1,200 horsepower will require the evaporation of $1{,}200 \times 35 = 42{,}000$ pounds of water per hour. Having 149,334 pounds of water in the tank, this will last $\frac{149{,}334}{42{,}000} = 3.555$ hours, or, say $3\frac{1}{2}$ hours.

Ques. 11.—If 40,000 cubic feet of air per minute are passing in a circular airway 8 feet in diameter and 1,800 feet long, what is (*a*) the pressure per square foot; (*b*) the horsepower required? (B. C., second class)

Ans.—(*a*) The formula for the pressure is $p = \frac{k\,l\,o\,q^2}{a^3}$, in which k = coefficient of friction = .00000002; l = length = 1,800 feet; o = the perimeter = $3.1416 \times 8 = 25.1328$ feet; q^2 = the square of the quantity of air circulating per minute = $(40{,}000)^2 = 1{,}600{,}000{,}000$; and a^3 = the cube of the area of the airway = $(.7854 \times 8^2)^3 = 127{,}038$. Substituting these values, p

$$= \frac{.00000002 \times 1{,}800 \times 25.1328 \times 1{,}600{,}000{,}000}{127{,}038}$$

$= 11.40$ pounds per square foot.

(*b*) The formula for the horsepower is, H. P. $= \frac{q\,p}{33{,}000}$, in which q = the quantity of air $= 40{,}000$ cubic feet; and p = the pressure per square foot = 11.40 pounds. Substituting, H. P. $= \frac{40{,}000 \times 11.4}{33{,}000} = 13.82$.

Ques. 12.—If with a water gauge of 1 inch, 20,000 cubic feet of air per minute are obtained, and afterward the quantity is increased to 60,000 cubic feet per minute; what would be the reading of the water gauge? (Ill., Mine Manager)

Ans.—No other changes being made in the conditions, the water gauge varies as the square of the quantities of air in circulation. Since the quantity of air has been increased three times $(60{,}000 \div 20{,}000 = 3)$, the water gauge will be increased 3^2 or 9 times. Hence, the original reading having been 1 inch, the new reading will be $1 \times 9 = 9$ inches.

Ques. 13.—If in extending the working of a mine where airways are kept of uniform size and condition, the water gauge shows an increased pressure, what, in your opinion, is its cause? (B. C., second class)

Ans.—When the only changes in the working conditions are those due to an increase in the length of the airways, the increase in pressure is directly proportional to this increase in length. Thus, if the length of the airways is doubled, the pressure will be doubled, and similarly for other proportionate increases in the lengths.

Ques. 14.—What thickness of pillars would you leave around the bottom of a shaft 450 feet deep, coal 7 feet thick, under coal 4 feet of fireclay, above coal 10 feet of soapstone, balance of covering is shale, sandstone, clay, and soil? (Ill., Mine Manager)

Ans.—There are many so-called rules for determining the depth of shafts none of which is of any value except under the conditions for which it was especially devised. That is, a rule that will give the proper dimensions of shaft pillar in the case of a 4-foot seam 2,000 feet deep at a mine in the north of England, will give absolutely impossible results when applied to a 7-foot seam but 450 feet deep in Illinois. For example, one of the best known of English formulas (most formulas are of English origin) is Merivale's, as follows: Diameter of circular pillar, or side of square pillar, in yards, is equal to 22 times the square root of the depth of the shaft, in fathoms, divided by 50. Applying this rule,

$$D = 22\sqrt{\frac{d}{2\times 50}} = 22\sqrt{\frac{450\div 6}{2\times 50}} = 22\sqrt{.75}$$
$$= 22\times .866 = 19.052 \text{ yards} = 57 \text{ feet},$$

about. The depth of the shaft, d = 450 feet, is divided by 6 to reduce it to fathoms as the rule requires.

Hughes's rule, also well known, is: For the diameter of a circular pillar, or the side of a square pillar, allow 1 yard for each yard in depth. According to this rule the diameter of a circular pillar or the side of the square pillar would be equal to the depth of the shaft, or 450 feet, as opposed to 57, say 60 feet, by Merivale's rule. That is, one rule requires a pillar 7.5 times thicker than the other; and other rules give intermediate values.

Another rule, known as the "Central Coal Basin Rule," and presumably founded upon the experience of mining men in Illinois and surrounding states, is: Leave 100 square feet of coal for each foot that the shaft is deep, it being understood that a main entry of average width is driven through this pillar. If the bottom is soft, the result given by this rule is increased by half. By this rule, the area of the shaft pillar should be not less than 100 × 450 = 45,000 square feet for good bottom, and for soft bottom, half as much again, or 67,500 square feet. The side of the corresponding square pillar would be 222 feet and 260 feet, respectively, and for the diameter of the circular pillar, 240 feet and 290 feet, respectively, the values being approximate only.

It seems better to use the "Central Basin Rule" than the others, as it is based upon experience in the district where the shaft is assumed to be sunk, and is intended to apply to mines worked upon the room and pillar method, whereas the others are designed primarily for longwall mines situated at much greater depths than those that prevail in Illinois.

It should be noted that none of the above rules make any allowance for the thickness of the seam, something that materially affects the size of the pillar. It requires but little thought to understand that when the coal is, say, 30 feet thick, much larger pillars must be left than when it is but 5 feet.

Unless mines in actual operation under the same conditions show the necessity for a larger pillar, the Central Basin Rule may be used, taking the larger values, since both the bottom and top are soft; that is, the side of a square pillar may be made 260 feet, and the diameter of a circular pillar, 290 feet.

Ques. 15.—How much work is done in raising 300 tons of coal up an incline 2,700 feet long, and raising 1 foot in 3, when the friction of car adds 40 per cent. to load? (B. C., second class)

Ans.—The difference in the elevation between the top and the bottom of the incline is 2,700 × ⅓ = 900 feet. The number of foot-pounds of work expended in raising 300 tons through this distance is 300 × 2,000 × 900 = 540,000,000. Since friction adds 40 per cent. to the amount of work required, the total work would be 540,000,000 × (1 + .40) = 756,000,000 foot-pounds. The distinction between work and horsepower should be noted. Work is the energy expended in raising a weight through a given distance and is independent of the time. There is just as much work required to raise the coal up the incline whether it is done in 3 minutes or in 3 hours; but if the length of time required to do this work is considered, the horsepower becomes a factor. Suppose the hoisting is done in 10 minutes actual running time. Since 1 horsepower calls for the expenditure of 33,000 foot-pounds of work in 1 minute, in 10 minutes it will do 330,000 foot-pounds, and to do 756,000,000 foot-pounds of work in 10 minutes will require 756,000,000 ÷ 330,000 = 2,300 H. P., about.

Ques. 16.—Where would you expect to find firedamp in a mine? (Ill., Mine Examiner)

Ans.—As all the air in the mine is gathered in the main return, gas will be found there if it exists in the other workings. In flat workings in shaft mines, gas is as apt to be found in one entry as another, but if the seam is pitching and the entries are connected by rooms driven through from one to another, more gas will probably be found in the rise workings than in those at greater depths. This will apply to seams which do not outcrop. Where the seam comes to daylight, the entries farthest from the outcrop will show the most gas, those near the crop probably being free from it. Places driven to the dip show less gas than those driven to the rise. Gas is apt to be found in the vicinity of faults, clay veins, and the like, and in the neighborhood of active or abandoned oil or gas wells, on top of

falls, and in all other places where ventilation is sluggish or wanting.

Ques. 17.—What would probably be the composition of the explosive mixture, if the afterdamp showed the presence of whitedamp instead of blackdamp, and why? (B. C., first class)

Ans.—The presence of whitedamp, or more correctly carbon monoxide CO, instead of blackdamp, or more correctly carbon dioxide CO_2, in any atmosphere resulting from the burning of substances containing carbon, indicates that the burning took place in the presence of too little air for complete combustion. The presence of carbon monoxide in the afterdamp of a mine explosion may come from a single source or (usually) from several sources.

While authorities differ, it is probably true that methane, or marsh gas, when exploded in a deficiency of oxygen, will burn to CO and not to CO_2 as it does when the air supply is ample. Similarly, if coal dust is in the mine air and the temperature of the explosion is sufficient to distill off the gases, these hydrocarbon compounds of the same general class as methane will probably burn to CO and water in a deficient air supply; as before, burning to CO_2 and water if air is abundant.

Again, if coal dust is present, and it is ignited by the explosion of the firedamp, the solid carbon in it will burn to carbon monoxide if the air supply is small and to carbon dioxide if the air supply is ample.

Finally, if any of the high explosives, such as dynamites, permissible powders and the like, or fuse and other substances containing carbon, are ignited by the explosion, they will give off fumes of carbon monoxide in exploding or burning.

Hence, while the presence of carbon monoxide in afterdamp always indicates that the explosion took place in a deficiency of air, yet the composition of the explosive mixture is not necessarily always the same and may be methane, or some high explosive, or coal dust, and is most commonly the latter.

THE PRIZE CONTEST

It has been decided to discontinue the Prize Contest department. Prize answers to the questions published in March will appear in the next issue.—Editor.

Answers for Which Prizes Have Been Awarded

54. Why are suction fans more generally used at anthracite mines than blowing or pressure fans? Give the advantages and disadvantages of both systems, and when, in your judgment, would it be best to use a blowing and when a suction fan? Conditions being the same, which would produce the largest volume of air, a suction or blowing fan?

Ans.—The general reason why exhaust fans are used in the anthracite mines is because the intake airway is mostly the haulage road and the downcast shaft the hoisting shaft; this could not be done with a blowing system without placing doors at the bottom of the shaft, which would not be practicable on account of interference with the hoisting and haulage of the coal.

Although the exhaust fan is not so efficient as the blowing fan, owing to the fact that it operates under a pressure below the atmosphere, the advantage of the exhaust fan is that the ventilation can be made ascensional if the conditions of the mine warrant, which helps the fan a great deal. The blowing fan is a good method of ventilating a mine where the haulage is done on the return; the gases by this method, when the seam is near the surface, are forced through the strata instead of being conducted all through the mine, as in the case of an exhaust fan. Considering the summer and winter seasons, the blowing fan would produce a somewhat larger volume of air under the same conditions.

Richard Bowen
423 N. Main St., Plains, Pa.
No Second Prize.

55.—What horsepower of engine will be required for circulating 100,000 cubic feet of air in two splits in a mine where the present circulation is 40,000 cubic feet in a single split and the water gauge is 1.75 inches?

Ans.—Power is the product of a force acting times the distance covered in a unit of time. The power, then, of a current of air is the total pressure P times the velocity V. If P is measured in pounds and V in feet per minute, the power will be in foot-pounds per minute.

$P = pa$ in which p = pressure in pounds per square foot and a = area of airway in square feet.

$V = \frac{Q}{a}$, Q being the quantity of air passing = cubic feet. Therefore,

$$\text{Power} = PV = pa \times \frac{Q}{a} = pQ. \qquad (1)$$

In looking at the equation $V = \frac{Q}{a}$ we notice that V varies directly as Q and inversely as a. Denoting the velocity of the air when 40,000 cubic feet were circulated in a single split, by V_1, and velocity when driving 100,000 cubic feet through two splits by V_2 we find that $V_2 = \frac{50{,}000}{40{,}000} V_1 = 1\frac{1}{4} V_1$ because the quantity in each split will be $\frac{1}{2} \times 100{,}000 = 50{,}000$ cubic feet in the second instance. The area in each split remaining the same.

In the formula $p = \frac{ksv^2}{a}$ we notice that p varies as the square of the velocity, directly as the rubbing surface and inversely as the area.

In this case the area and rubbing surface remain the same in both in-

stances for each split but the velocity changes.

Therefore, $p_1 : p_2 = V_1^2 : V_2^2 = 1^2 : 1\frac{1}{4}^2$.

Solving, $p_2 = 1.5625\ p_1$.

$p_1 = 5.2$ water gauge $= 5.2 \times 1.75 = 9.1$.

$p_2 = 1.5625 \times 9.1 = 14.21875$.

$$\therefore \text{Power}_2 = \frac{p_2 \times Q_2}{33{,}000} = \frac{14.21875 \times 100{,}000}{33{,}000} = 43.087 \text{ horsepower.}$$

$= 1{,}421{,}875$ foot-pounds per minute

W. E. Hobson

Jenkins, Ky.

Second Prize, Richard Williams, Wilkes-Barre, Pa.

56.—Wishing to provide for a possible circulation of 200,000 cubic feet of air per minute under ordinary mining conditions, which fan would you adopt, and why: a fan designed to throw 200,000 cubic feet of air against a 6-inch water gauge, or a fan designed to yield the same volume of air against a 2-inch water gauge?

Ans.—A certain size fan running against a 6-inch water gauge will produce 200,000 cubic feet of air per minute. A larger fan operating against 2 inches will produce the same quantity. The question is, to determine how much money it is practicable to spend for the larger fan in excess of the cost of the smaller fan.

The horsepower required to operate the smaller fan would be the product of a quantity of air by the pressure, divided by the number of foot-pounds of work per minute in 1 horsepower, or

$$\text{H. P.} = \frac{q \times i \times 5.2}{33{,}000} = \frac{200{,}000 \times 6'' \times 5.2}{33{,}000} = 189$$

Similarly, for the larger fan

$$\text{H. P.} = \frac{200{,}000 \times 2'' \times 5.2}{33{,}000} = 63$$

At a cost of $30 per horsepower year, it would cost $30 × 189 = $5,670 per year for power for the smaller fan, while the larger fan would cost $30 × 63 = $1,890 per year for power. By using the larger fan, a saving in power cost of $5,670 − $1,890 = $3,780 could be made.

Allowing a total of 10 per cent. for interest, depreciation, and repairs, and since $3,780 represents 10 per cent. of $37,800, then it would pay to put in the fan designed to operate at 2 inches water gauge if it could be purchased and erected for any sum not exceeding the cost of the smaller fan by more than $37,800.

It may be noted in conclusion, that the same size fan could be used in either case if water gauge were reduced from 6 to 2 inches by straightening or increasing the size of the airways, splitting the air-current, or sinking an air-shaft, and for this work it would be reasonable to spend any amount less than $37,800.

M. D. Cooper

Ellsworth, Pa.

Second Prize, Joseph Northover, Seanor, Pa.

Ques. 57.—With an airway 6 feet by 9 feet and 4,620 feet long and a current of air passing through it at 480 feet per minute, what would be the quantity of air passing in a minute, the pressure in pounds per square feet, the water gauge, and the horsepower?

Ans.—The quantity of air passing through a certain airway is equal to the product of the velocity and the sectional area of the airway; that is $q = av$, in which

q = quantity of air in cubic feet per minute;

a = sectional area in square feet;

v = velocity in feet per minute.

In the question v is given as 480; a is the product of height × width of airway = 6 × 9 = 54 square feet, so $q = 54 \times 480 = 25{,}920$ cubic feet per minute.

The total pressure which is equal to the pressure per unit area times the area, is overcome by the total friction and acceleration. Pressure = friction × acceleration.

The total friction equals the coefficient of friction times the rubbing surface; acceleration equals velocity squared. Therefore, $P = pa = ksv^2$, in which

P = total pressure in pounds;

p = pressure in pounds per square foot;

a = sectional area of airway in square feet;

k = coefficient of friction = .0000000217 as found by experiment;

s = rubbing surface in square feet;

v = velocity in feet per minute.

The rubbing surface s equals the perimeter of the airway, 6 + 6 + 9 + 9 = 30; multiplied by the length, 4,620 = 30 × 4,620 = 138,600 square feet.

Therefore, $p \times 54 = .0000000217 \times 138{,}600 \times 480^2$.

Solving out, $p = 12.85$ pounds per square foot.

The pressure per square foot divided by 5.2 equals the water gauge reading in inches.

Hence, 12.85 ÷ 5.2 = 2.47 or very nearly 2½ inches of water gauge.

Power is the product of the force times space passed through in a unit of time. The force in this case is the total pressure in pounds and the space passed through in a unit of time is the velocity in feet per minute. The unit of power by using the above units, will be foot-pounds per minute, so to reduce this to horsepower, divide by 33,000 which is the number of foot-pounds per minute in one H. P.

$$\text{Power} = PV = p\,a\,V = 12.85 \times 54 \times 480 = 333{,}072$$

foot-pounds per minute.

$$\text{H. P.} = \frac{333{,}072}{33{,}000} = 10.94 = \text{horsepower}$$

of ventilating current.

W. E. Hobson

Jenkins, Ky.

Second Prize, E. C. Lee, West Pittston, Pa.

The United States Government estimate shows that only one state in the union has more coal than West Virginia. A late calculation of the world's reserve shows 4,000,000 million tons of bituminous coal still unmined, and of this amount 271,080 million are in America. Dr. I. C. White, the West Virginia State Geologist, declares that there are 55,000 million tons of unmined coal in West Virginia. The entire world uses a little over a billion tons a year.

NEW MINING MACHINERY

Hammer vs. Piston Rock Drills

One of the most useful additions to mining is the perfected hand-hammer rock drill, known in various mining sections by different names such as

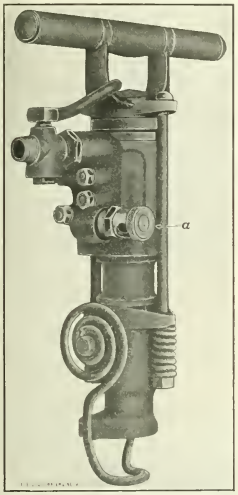


Fig. 1. Hammer Drill, Showing Special Valve *a* for Directing Air Through the Hollow Steel

"Plugger" drill, "Jap" drill, "Jackhamer," etc.

This drill is now extensively employed for such purposes as sinking shafts, digging trenches, trimming tunnels, block-holing boulders, quarry work about mines, stripping coal land, drilling in coal bands, taking down roofs or taking up floors, etc.

The hand-hammer drill is a one-man machine, its weight being from 20 to 50 pounds, and this has brought it into general popularity. This is aside from the usefulness of the hand-hammer drill in restricted quarters, more drills may be employed per unit of space due to the elimination of bars, tripods, bar arms, wrenches and the elimination of helpers.

The adoption of these drills has been accomplished without any sacrifice of speed; on the contrary, they have proven a material aid in securing results greater than could be obtained with other drills, and this is leaving out of consideration certain other advantages inherent in the hand drill. It must be kept in mind, however, that this article applies only to work for which the hand-hammer drill is adapted, as there are certain limitations to its possibilities.

The time factor in drilling consists of the following elements: Mounting the drill; drilling the hole; shifting position; removal.

As the drills of which this article treats are used without mounting, the element of time in mounting is eliminated.

The element of time consumed in drilling the hole depends upon the depth and diameter of the hole to be drilled, the method of applying the power to the bit, the facility with which steels may be changed and the manner in which the drill hole is kept clean of cuttings.

With mounted drills in which the drill steel reciprocates with the piston, it is necessary to employ steels of large diameter, with corresponding large bits, owing to the heavy blows and the severe shocks to which the steel is subjected. Moreover, the bit

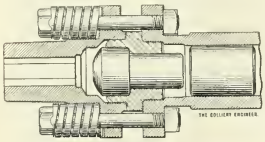


Fig. 2. Front Head of Hand Hammer Drill Showing Anvil Block Between Piston and Steel Shank

in rubbing against the walls of the hole, wears rapidly.

In contrast to this, the hand-hammer drill steel is not reciprocated with the piston, but rests loosely in the chuck and is struck a great many

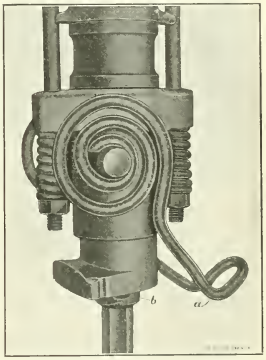


Fig. 3. Steel Holder. *a*, Holder Unfastened, *b*, Collar on Drill Steel

light blows by a rapidly moving piston, the bit end of the steel being at all times against the rock. It will be evident that the movement of the steel is very slight on the rebound as compared to the reciprocating movement of several inches with the mounted type. This great reduction in rubbing against the walls of the hole lessens the wear on the wings of the bit, so that with bits of smaller gauge variations may be employed; that is, to obtain a certain diameter at the bottom of the hole, a smaller size of starter bit may be employed than would be advisable with the mounted drill. In the mounted drill shown in Fig. 6 the steel is rigidly clasped to the piston rod; in the hand hammer it rests loosely in the chuck and is prevented from going too far into the cylinder by a collar on the shank of the steel

or by means of an anvil block shown in Fig. 2 interposed between the end of the steel and the piston. This construction consumes less time while changing steels or in removing steels

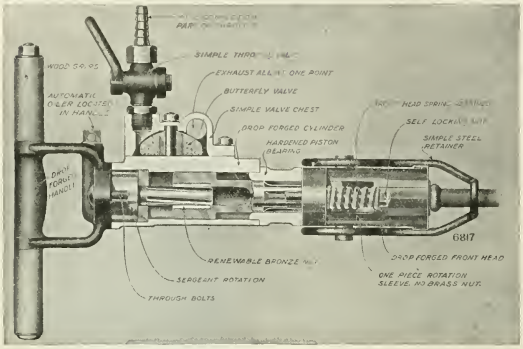


Fig. 4. Rotating Mechanism of Drill

to clean the hole. With the drills having automatic hole-cleaning features shown in Figs. 1 and 4 the time consumed in cleaning the hole may be practically eliminated from consideration.

The time required for removing the steel from the hole is reduced by means of a steel holder shown in Figs.

Fig. 5. Hand Rotated Hammer Drill

1 and 3, constructed so that it can be slipped into place quickly.

In the mounted drill the steel is invariably automatically rotated. In the hand drill there are two methods of rotation, by hand and automatically. Fig. 5 shows a hand drill whose steel the drill runner must constantly rotate back and forth through an angle of about 45 degrees or the hole will become rifled so that the steel will stick and cause delay in its removal. Fig. 4 shows the rotating mechanism of the self-rotating drill. It is apparent that a drill embodying automatic rotation will produce a more uniform hole and will relieve the operator of the most irksome part of his work, thus permitting him to work faster and require fewer periods of rest.

The time required for mounting and for the various operations of shifting mounted drills is often greater than the actual time of cutting, whereas with the hand-hammer drill this element is practically eliminated, it requiring but a few seconds to shift.

When it comes to removing the equipment preparatory to blasting, the absence of mounting, aside from the great differences in weight, about 250 pounds as against about 40 pounds, is an important item in favor of the hand-hammer drills.

Of course the hand-hammer drill has its limitations, principal among which is the depth of the hole that may be drilled economically. This varies, depending solely upon the nature of the ground to be drilled. In extremely hard rock the drilling range has been as low as 5 or 6 feet, in medium ground around 12 feet, and in favorable ground around 20 feet.

As might be expected from what has been stated in this article the actual record of accomplishment in rock drilling has been greatly in favor of the hand-hammer machine drills for classes of work falling within their proper range.

Bristol's Pneumatic Type Recording Tachometer

The field of usefulness of recording tachometers is almost unlimited because there is a great need for measuring and controlling the revolutions of shafting, machinery, engines, etc. In case of mine fans it is desirable to have a certain speed or number of revolutions maintained continuously, and the recording tachometer provides the superintendent with information about the actual operating conditions maintained.

In many instances it is not convenient to have a recording tachometer installed near the revolving shaft. One of the special features of Bristol's pneumatic recording tachometer is the flexible connecting

Fig. 6. Drill of the Mounted Type

tube 25 feet long, or longer, between the revolving mechanism and the recording instrument which is mounted in any convenient position,

as for instance, on a switchboard or the wall of an engine room.

The pneumatic principle of operation depends on the centrifugal action of the air in a revolving tube which is connected to the recorder through a special oil seal and flexible connecting tube.

connecting tube *G*, leading to the recording instrument.

The recorder used with this measuring device is a special low range Bristol recording vacuum gauge. The recording instrument may be installed either near to or at a distance from the shaft or engine, the

distance apart by axle straps or stirrups made of bar steel. However, as the works were extended, haulages became long, cars were made larger, animals gave way to mechanical haulage, in fact, operations enlarged and requirements changed. Under these conditions, stirrups

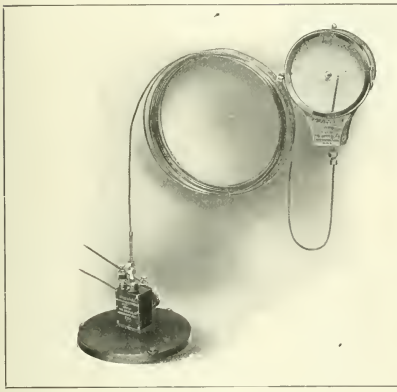


Fig. 7. Pneumatic Recording Tachometer

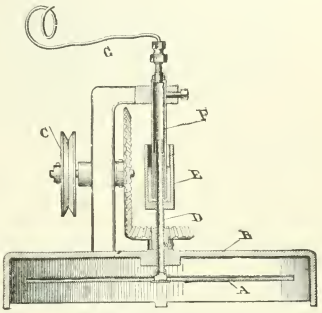


Fig. 8

Fig. 8 shows diagrammatically the construction of the revolving mechanism. In the diagram, *B* is a hollow circular protecting base and at its upper surface is provided a bearing for a hollow shaft *D*. This shaft is arranged to be rotated from any desired mechanism through a set of gears and pulleys (or sprockets).

A pulley *C* is shown, over which a belt runs to a similar pulley attached to the shaft whose revolutions are to be measured and recorded. In practice most of these tachometers are furnished with special form of sprocket and chain instead of pulley and belts.

The lower end of the hollow shaft *D* terminates in a horizontal tube *A*, open at its extremities. The upper end of the hollow shaft is surrounded by a casing *E*. It is partly filled with oil and into this extends the free end of another tube *F*. The tube *F* is stationary and is joined at its outer end to a flexible capillary speed of which is to be recorded, and a suitable length of flexible copper tubing is furnished to connect the recorder with the revolving tube.

These patented tachometers are manufactured by the Bristol company who also manufacture electrical tachometers.

A New Mine Car Truck

It has not been many years since mine cars were generally provided with square axles, held the required

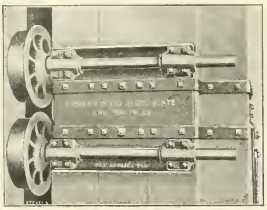


Fig. 9

worked loose, the alinement of the axles was disturbed, the wheels could not run truly on the rails, cars "jumped the tracks," wrecks followed, losses resulted.

Round axles and boxes, while they improved construction, did not perfect the running gear of the car, as each box, being attached independently to the bottom of the car, could work loose and destroy the alinement of the axles with as disastrous results as before.

Various methods and designs have been adopted to correct this defect; in no instance, however, were all four boxes connected by a single unit, until the solid flanged plate was designed, as shown in the Stevens truck, Fig. 9.

The plate is made of ¼-inch steel, and is flanged so as to enclose all four boxes. This brings both axles together into a single unit which insures a permanent alinement. Repairing or replacing boards or plates

in the cars can in no way disturb the accurate alinement of the axles. The axles run freely in the boxes, the wheels run truly on the track without a tendency to derail, and wrecks are avoided.

The flanged metal plate together with the two middle binders shown, hold the cast-iron bearing boxes rigidly, and, at the same time, substantially unite the truck with the car body, thus insuring strength and durability. This method of construction is used in the cars designed and manufactured by the Harris-Stevens Co., of Pittsburg, Pa.

Brush-Shifting Polyphase Motor

Possibly the only installation in the United States of a brush-shifting polyphase commutator motor, directly connected to a mine fan, is at the Aultman mine of the Jefferson and Clearfield Coal and Iron Co., near Jacksonville, Pa.

The installation referred to is a Robinson turbine reversible fan, 5 feet 3 inches in diameter, connected to a 100-horsepower General Electric motor running with 440 volts, three-phase, 25 cycles, at 360 revolutions per minute. At this speed the fan has a capacity of 100,000 cubic feet of air per minute at a 3-inch water gauge. The current is delivered to the motor from the power house about 8 miles away, at 6,600 volts and is there transformed to 440 volts. By means of the handwheel attached to the motor, shown in Fig. 10, the brushes are shifted, and any desired speed can be obtained.

The running is economical and with the desirable quality of speed changing and economy in current consumption, it will no doubt be in demand in mining fields.

The motor is interesting inasmuch as sparkless commutation is perfected. Dr. H. Meyer-Delius in the *General Electric Review*, says in discussing the theory of the motor:

"In a direct-current motor, the standstill current would be prohibitively large and starting resistances are always required. This fact makes the controlling apparatus for alternating-current motors very simple.

The diagram, Fig. 11, is of a special practical motor invented by Professor Goerges, of Germany,

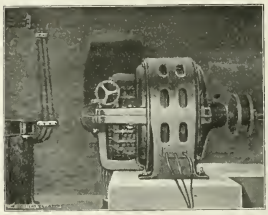


Fig. 10 Brush-Shifting Polyphase Motor

which was exhibited in 1891 in Frankfurt, Germany. It is only recently that the conditions at the alternating-current commutator have been sufficiently cleared so that such a motor could be designed to operate with sparkless commutation, which was, of course, necessary before it could be marketed.

The connections for three-phase current are shown in Fig. 11. The stator is a normal induction-motor stator with one three-phase winding distributed in small slots and connected in Y. The Y point is formed by the rotor winding, which is connected in series with the stator winding over three equally spaced

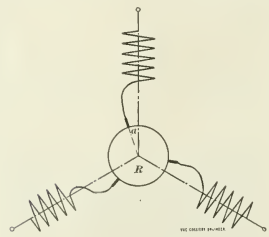


Fig. 11

brushes sliding on the commutator. The rotor is an entirely normal direct-current rotor. The brushes are mounted on a movable brush yoke so that any brush position may be obtained.

As a normal induction motor, the stator winding excites a nearly uniform sine-shaped field, and so does the similar rotor winding. Therefore, the field resultant from the stator and rotor ampere turns is also of sine shape, whatever the brush position may be, so that practically no disturbing local fields appear.

Suppose the ampere turns of stator and rotor to be exactly equal in strength, and the brushes put in the same axis as the corresponding stator winding. The stator winding completely neutralizes the rotor winding over the whole circumference; no field is excited, and the stator winding acts as a plain compensating winding.

Next, shift the brushes over a certain angle *a*, as shown in Fig. 11. Stator and rotor ampere turns no longer balance each other and the resultant ampere turns excite a field of sine shape, as before, proportional to the current and the angle of brush shift. A torque is developed by the field reacting on the current in the rotor winding. The motor is a plain series motor. A constant current assumed, the field increases with larger brush shifts. As in a direct-current motor, the speed varies nearly inversely proportional to the field. The brush shift therefore controls the speed in a very simple manner without any auxiliary controlling apparatus.

If the brushes are shifted over 180 degrees, stator and rotor and rotor ampere turns are again in the same axis; instead of bucking they act in the same sense. The torque is zero and the motor takes only a very small current from the line, since the impedence of the two windings in series is very large. This position is therefore well suited for connecting the motor to the line. By shifting the brushes forward, torque gradually develops until the motor starts and comes to the desired speed.

For the lower speeds the power factor must drop, because too large a wattless field would be needed to balance the reactance drop at the

low speed. The necessary increase of the rotor ampere turns would be incomparatively large, and the size and cost of the motor would grow too much and the efficiency would drop.

Self-Rescuing Apparatus

Self-contained rescue apparatus dates back to 1857, but it is one thing for a man equipped with a device of this kind to enter a mine after an explosion and quite another thing for a man on the inside to penetrate the deadly fumes in order to save himself. This has been one of the most important problems to contend with in mine rescue work, and inventors have given their energies to this subject for some years. In the United States the larger mining companies are now quite completely equipped with rescue apparatus to enable rescue brigades to enter mines after an explosion or during a mine fire in order to protect property and save life. A device is now introduced for the first time for the unfortunate miner who has been hemmed in by afterdamp to escape from the mine, and the valuable features of this apparatus are that it is light, simple, compact, may be quickly adjusted, and is said to be sufficiently inexpensive to warrant quite extensive installations to be made by mining companies, thus

Fig. 12

enabling a large number of men to rescue themselves.

The apparatus is known as the Draeger Self-Rescuer, and is sold by the Draeger Oxygen Apparatus Co., of Pittsburg, Pa. This new, small apparatus consists of four parts: an oxygen cylinder with closing valve, a small potash cartridge, a breathing bag, and a respiration pipe with a mouthpiece connection. It folds in a compact package to be carried as shown in Fig. 12, when not in use.

The apparatus is held in place by a leather strap fastened to a metal frame, and all that is necessary is to place the mouthpiece in position, clamp the nostrils, and fill the breathing bag with oxygen from the cylinder. As soon as this is used by the wearer it is refilled, the products of respiration being constantly and completely removed by transmission through the potash cartridge, which is so placed that it permits the products of respiration to pass through the potash twice before being again breathed. The little apparatus is useful for 30 minutes of work or 45 minutes if the wearer is at rest. There seems to be a wide range of usefulness for this machine as it may be of service, not only for self-rescue work after an explosion, but on account of its lightness it can be worn by superintendents, mine bosses, or fire bosses when they enter a mine for inspection purposes. It weighs but 6½ pounds and is, therefore, not much more of a load than an ordinary safety lamp would be and if it is desired to use it in low coal this can easily be done by carrying it on the back. It has also been used quite extensively in Europe in other industries than mining, wherever it is desired to accomplish work for a short period of time in any kind of gas.

It is interesting to watch the developments in mine rescue work and to see that the men who are devoting so much time and energy to increased efficiency along this line are accomplishing results.

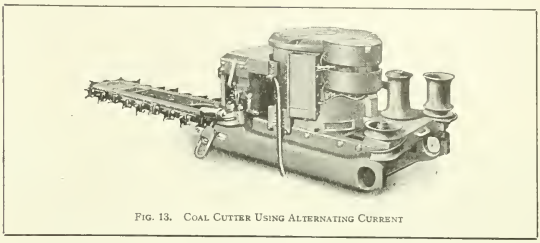


Fig. 13. Coal Cutter Using Alternating Current

A New Coal Cutter

To meet the demand of the operators located near transmission lines of the many large central power plants producing alternating current, a new alternating-current short-wall coal cutter, shown in Fig. 13, has been brought out by the Morgan-Gardner Electric Co.

The motor has mechanical strength; ample overload capacity; and the small number of parts assure continuous operation with practically no attention. This motor, which is exceptionally well ventilated, makes use of the Star-Delta control which is the most simple and satisfactory control for induction motors of this capacity.

The stator, which can be quickly removed from the motor body, has waterproofed core disks riveted together under hydraulic pressure. The stator coils are form wound and impregnated with a moisture and oil resisting compound that will stand a high degree of temperature, these coils are laid in open slots and easily accessible.

The rotor is fireproof the bars being imbedded in a special moisture and heat resisting cement. The short-circuiting rings are cast solid

with the bars, leaving nothing on the rotor to work loose. There are three self-alining ball bearings to insure cool running and long life, and as the air gap is always uniform, the rotor cannot strike the stator. These bearings are dirt-proof and lubricated with grease.

The construction of the rest of this machine is identical with the Morgan-Gardner direct-current short-wall machine.

The Coppus Turbo Blowers

The Coppus is an under-grate draft blower consisting of a propeller fan driven by a steam turbine of the impulse type, both on the same shaft. The exhaust steam is discharged through a pipe into the fan casing. The steam thus thoroughly mixes with the air, not only heating it, but also preventing the formation of clinkers. At a recent test made at the boiler plant of the Upper Lehigh Coal Co., at Upper Lehigh, Pa., where the average capacity of the five boilers equipped with steam blowers was 1,935 horsepower per hour, it was shown that a Coppus blower was as powerful as four of the strongest steam blowers.

After the new blowers were installed, the same amount of steam was supplied to the breaker by four of the boilers only, with an average capacity of 415 horsepower or a total of 1,660 horsepower per hour. The difference of 275 horsepower, therefore, was consumed by the steam blowers, or each Coppus blower was taking 69 horsepower less than the steam blowers. The Coppus blowers are manufactured by the Coppus Engineering and Equipment Co.

TRADE NOTICES

The A. S. Cameron Steam Pump Works, 11 Broadway, New York, announces the opening of a branch office and warehouse in the city of Philadelphia, in Commercial Trust Building, under the management of Mr. Phil Weiss.

The Ingersoll-Rand Co., has appointed George A. Gallinger, of Pittsburg, in charge of their pneumatic tool department, with the title of Manager of Pneumatic Tool Sales. His headquarters will be at 11 Broadway, New York City. After an experience of 12 years in developing a general line of pneumatic tools, the Ingersoll-Rand Co. felt warranted in establishing this special department and in placing at the head of it a man who understands the business from a mechanical as well as a commercial standpoint. Mr. Gallinger's time and service are at the disposal of those contemplating the use of pneumatic tools and his long experience and practical knowledge commend him to the best consideration and interest of the trade in general.

A Textbook on Disk Mine Fans. The J. C. Stine Co., of Tyrone, Pa., has just issued a very complete catalog illustrating many different means of operating J. C. Stine patent disk mine fans. The catalog not only describes and illustrates the fans and their motive power, but gives, in considerable detail, authenticated statements of the performance of various sized fans in practical operation at many mines. It contains a great deal of information regarding sizes of disk fans required for specific work, and the statements made by Mr. Stine in preparing the booklet are substantiated by letters from numerous prominent mine operators and managers. While primarily a catalog, it contains so much of interest to mine managers having ventilation problems to solve, that advantage should be promptly taken of the offer of the J. C. Stine Co. to send copies free on request.

The Concordia Safety Lamp Co. has been established in Pittsburg, with offices in the Manufacturers Building, as a branch of Concordia E. A. G., Dortmund, Germany, manufacturers of electric lamps and electric apparatus for mines. The Concordia E. A. G. electric lamp was the winner in the British Home-Office competition in 1912, and a supply of these lamps and their fittings will be carried in stock. The company also expects shortly to market an electric storage-battery cap lamp. The engineering department of the new company will be in charge of Mr. R. Koch, and the sales will be managed by Mr. Wm. Domnich.

CATALOGS RECEIVED

S. F. Hayward & Co., 39 Park Place, N. Y. Oxygen Reviving Apparatus, circular.

Herzler & Henninger Machine Works, Belleville, Ill. Circular, H. & H. Automatic Self-Dumping Cage.

American Fuel Saving Co., 547 Leader-News Building, Cleveland, Ohio. Some Interesting Evaporative Boiler Tests, 12 pages.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Chicago Coal Drills, 12 pages.

Sullivan Machinery Co., 122 S. Michigan Ave., Chicago, Ill. Sullivan Hammer Drills, 4 pages.

Richardson-Phenix Co., Milwaukee, Wis. Phenix Sight Flow Indicator, 8 pages.

Wm. Powell Co., Cincinnati, Ohio. Circular, Powell Valves, The Powell Patent "Model Star" Valve.

Hyatt Roller Bearing Co., Newark, N. J. Hyatt Roller Bearings as applied to Mine and Industrial Cars, 24 pages.

A. F. Plock, Pittsburg, Pa. Hinkel's Patent Safety Stop. 32 pages.

J. C. Stine Co., Tyrone, Pa. Bulletin No. 18, The J. C. Stine Co. Patented Disk Fans and Machinery, 24 pages.

National Tube Co., Frick Building, Pittsburg, Pa. "National" Pipe For Drilling Purposes, 8 pages; List of Products, 8 pages; N. T. C. Regrinding Valves, 14 pages.

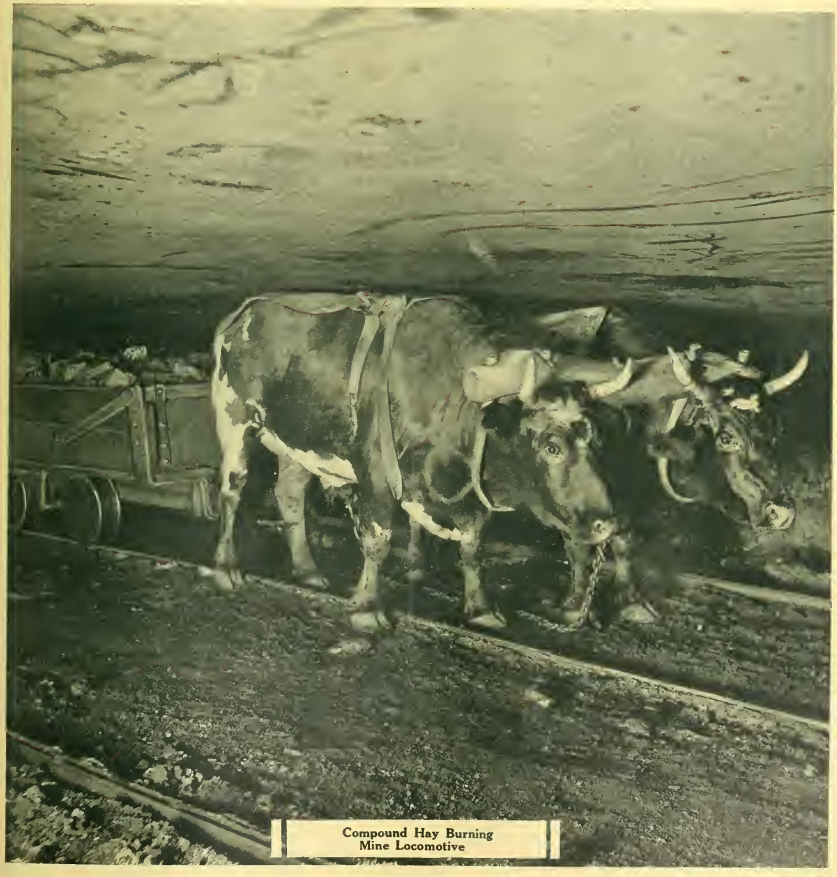
Hess-Bright Manufacturing Co., Philadelphia, Pa. Ball Bearings and Their Correct Use as Applied to Various Machinery, 17 pages.

The Colliery Engineer

Vol. XXXIV—No. 10 MAY, 1914 Scranton, Pa.

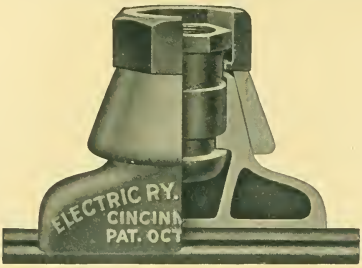
Alphabetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68



Compound Hay Burning Mine Locomotive

The "SURE GRIP" on Trolley Lines



means absolute safety

For once the "Sure Grip" clamp gets a hold on the wire it's there to stay. The possibility of hanging wires and consequent accidents to men is absolutely eliminated.

The Sure Grip is a positive safety device for trolley lines. It makes men feel safe—helps them to do more and better work because they **know** the absence of this common danger.

Made in all sizes. 1-0 to 4-0 in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine & Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

Arthur L. Ware
Jellico, Tenn.

Superior Supply Co.
Bluefield, W. Va.

HOISTING ROPES **HAULAGE ROPES**

HAZARD WIRE ROPE

Trade Mark

Rubber Covered Wire **Bare and Weatherproof Wire**

HAZARD MFG. CO.

WILKES-BARRE, PA.

NEW YORK 531 Canal St. | PITTSBURGH 1st Nat'l Bank Bldg. | CHICAGO 552 Adams St.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah (Office Atlanta) Cleveland
San Francisco Los Angeles
Seattle Portland, Ore.

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

A Monthly Journal Devoted to Mines and Minerals

Vol. XXXIV—No. 10 MAY, 1914 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.

ESTABLISHED 1881

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer
RUFUS J. FOSTER, Vice-President and Managing Editor
EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor
CHICAGO OFFICE: 1006 S. Michigan Ave.
Entered at the Post Office at Scranton, Pa., as second-class matter
Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your FORMER as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE, 15,000

TABLE OF CONTENTS

Editorial—
A Person and a Personality—Keep on Rowing—Anthracite Dust—"Mountains of High-Grade Coal"—Unfair Criticism of Bureau of Mines 587
Personals 589
Machine Mining in Room Pillars, by J. C. Edwards 591
Coal Mining Institute of America 594
Opening Nova Scotia Coal Mines, by C. M. Odell 595
Belgian Coal-Dust Precautions 599
Mine Inspectors' Institute 601
Pond Creek Coal Co., by Wm. Z. Price 602
Electric Mine Gas Detectors, by Sydney P. Walker 604
Kentucky Mining Institute and First-Aid Contest 606
Ravenswood Explosion and the Coal-Dust Question, by Samuel Dean 607
Operating Induction Motors, by C. A. Tupper 609
Portable Branch Track, by Joseph Kober 611
The Personal Equation in Engineering, by William Griffith 612
The Employer's Duty, by M. C. Butler 615
Illinois Mining Institute 617
Correction 617
Columbia School of Mines 618
Safeguarding Electricity in Mines, by W. E. Freeman 619
Then and Now 620
Model Mine in National Museum 621
Priming the Shot 622
Benzine Locomotives, by A. J. Baijot 623
Obituary—
George Westinghouse—James B. Davies 629
Notes on Mines and Mining 630
Pennsylvania Anthracite Section A. I. M. E. 631
The Mineral Man, by Neill Robinson 632
Coal Output Per Man, Various States 634
Miners' Phthisis 634
Letter Box—
Haulage Problem—Gases and Ventilation—Information Wanted—Qualifications for Certificate in Alberta—Method of Mining Wanted 635
Destruction in Mexico 636
Examination Questions—
Mine Foreman, Sheridan, Wyo., 1914 637
Prize Contest 640
Book Review 643
Catalogs Received 643
New Mining Machinery—
Safety Application of the Swing-Gate Valve, 644—Making the Truck Pay, 646—Automatic Self-Dumping Cage, 646—Storage-Battery Mine Locomotives, 646—The Simplex System, 647—A New Mine Pump, 648—Combination Tool for Miners, 648—The J. C. Sine Duplex Pump, 649—Perolin for Boilers 649
Trade Notices 649
Squibs—
On the Bulletin Board, 594—Coal Field History, 598—Magyars in West Virginia, 601—Steel vs. Iron Boiler Tubes, 622—Science and Industry Allied, 630—Mining Education 636

A Person and a Personality

SENECA, a great Roman writer and philosopher, once said: "We complain that life is too short, yet we live each day as if it were a thousand years."

The life of the average individual is principally occupied in rendering excuses, making explanations, and in listening to idle gossip.

The average man makes but little of his chances, which assertion is proved by the fact that a few men in one day of 8 hours often accomplish more than many men in a lifetime of 70 years.

Life is simply a matter of concentration. You are what you set out to be. The things you read today and the things you think today are the things you become tomorrow. You are a composite of the things you say, the books you read, the thoughts you think, the company you keep, and the things you aspire to become.

So, then, here is a recipe for improving the individual and evolving your life into success. Time is your only asset. Each moment is a golden treasure and the way you spend it shapes your life as an individual.

If you would simply devote 30 minutes of each day to the study of some splendid idea, to the improvement of your mind, in obtaining a more accurate knowledge of your business, in studying the thoughts of some great man who has left the world better because of his having lived, in search of the great secret of the success of great business men, you would in 10 years time evolve into a giant of intellectual strength with power to follow any plan or idea to final and positive success.

That is what you can actually do through the right investment of 30 minutes of each day.

Time knows no prejudices, makes no promises, keeps no records, and asks no questions. You are here for a purpose and each moment you spend foolishly or frivolously is lost for all time—simply thrown into the waste basket of indifference. You come into this world from an eternity of which you know but little, watch the hour hand on the face of time for a little while and return to that eternity from which you have come.

Unless you know the value of each moment as an investment, each day that passes is only a stumbling block that sends you blundering on into the indifference, helplessness, and decline of old age.

Then the question is—what are you going to do with each hour, and what are you going to do with life? Are you going to drift through its wealth and beauty,

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY ALL RIGHTS RESERVED

satisfied with your inefficiency, incompetency, idleness, and ignorance? Are you going to leave untouched the treasures of the world in which we live? Are you going to betray yourself and your chances?

Are you going to remain content with your own limited knowledge when you can keep in touch with the great thoughts and ideas of the great men who have influenced the world? Are you going to bury yourself and shut out the light of experience and the success of other men?

In other words—are you going to be a failure and in the evening of life go down the other side without having accomplished some great and splendid thing? Are you going to use those 30 minutes each day, to know more, to learn more, and to understand? It is up to you.

Opportunity is pounding a perpetual tattoo on your door and follows you with a club from the time of your rising to the time of your retiring. The question is—are you going to be a person or a personality?

The way you invest this half hour is going to decide, and your life's work will say if you have been a success or if your life has been a travesty—a mockery filled with idleness, indifference, and uselessness.

Do you believe in your work, in loyalty to your employer, in devotion to your business? Do you believe in honest service, in honest thought, in the divinity of the thing you do or the thing you sell? Do you intend to be an individual or a nonentity? As a man it is absolutely and entirely up to you. Are you going to get busy and when do you expect to begin?

Everyman

Keep on Rowing

HAVE you ever watched a strong, active man row a boat up stream? If you have, you noticed that as long as he pulled on the oars he made progress. When he ceased rowing he drifted back. To regain the lost distance he had to use as much exertion as he used when he first traversed it. But, he felt it more. His tired muscles did not respond as easily as they did the first time.

Have you ever watched the career of a mine official? If you have, you noticed that as long as he used his brain, as long as he was interested in reading and studying improved mining methods, as developed from time to time, he advanced up the stream of success. When through loss of ambition, or through a mistaken notion that he "knew it all"—that he could learn nothing more from the successes of others—he ceased to "pull on the oars"—he began to drift downward.

A mine official must advance or recede. He cannot stand still. Even when he reaches the head of the stream, he must continue to "row." If he doesn't he soon becomes a back number, and the more aggressive active man reaches his landing, and, with greater knowledge forces his boat from the wharf of position, and causes it to drift back.

Anthracite Dust

THE United States Bureau of Mines has proved conclusively that Pennsylvania anthracite dust is not explosive.

For over 30 years The Colliery Engineer has persistently stated that bituminous coal dust is explosive, and that its degree of explosibility depended upon the percentage of volatile hydrocarbons in the coal.

It as persistently ignored statements that Pennsylvania anthracite dust was explosive, basing its policy on the fact that anthracite is low in volatile hydrocarbons, and on the result of some experiments made about 25 years ago.

At the time of the attempt to compel the use of the Shaw Gas Detector in all Pennsylvania coal mines, the writer, who strenuously opposed the proposed legislation, both editorially and verbally, had many interviews and controversies with Mr. Shaw. During all of this time, and in fact, up to the time of Mr. Shaw's death, the differences of opinion did not result in any personal enmity.

In the course of one interview, Mr. Shaw said he doubted the explosibility of coal dust, and expressed his belief that so-called dust explosions were either explosions of large bodies of gas, or of comparatively large bodies in the presence of dust which might intensify the explosion.

As a result of this discussion, Mr. Shaw obtained a small quantity of bituminous coal, reduced it to an impalpable powder, and in the presence of the writer, with a specially contrived brass tube, a spirit lamp and a blow pipe, he produced a small explosion of considerable force. A similar test made with the dust of Pennsylvania anthracite resulted in failure to cause an explosion.

Recently, a writer in a contemporary, writing on the findings of British investigators, said: "The scientific conclusion, therefore, is that the violence of a dust explosion depends, not on the volatility of the coal, but on the calorific value of the dust. If this is true, anthracite dust, though difficult to inflame, will ultimately produce an explosion as violent as those produced by high-grade bituminous coals."

The fallacy of this notion was proved 25 years ago in Mr. Shaw's laboratory, and has again been proved by the larger and more exhaustive experiments of the Bureau of Mines.

The anthracite coal used in the Bureau of Mines experiments was from the Alden colliery in the Wyoming, Pa., coal fields. Its calorific value is about 14,900

B. T. U., and its percentage of volatile hydrocarbons is about 4. The dust of bituminous coals of practically the same calorific value (and some of less calorific value), but with from 5 to 10 times as large volatile hydrocarbon contents, has, as is well known, exploded with very disastrous results.

"Mountains of High-Grade Coal"

NEARLY a year ago President Wilson sent a personal representative to make a tour of the Territory of Alaska, and make a detailed report of his observations to the White House. The personal representative was Seth Mann, who went to Alaska with the Alaska Bureau of the Seattle Chamber of Commerce. He recently made his report to the President. In it, speaking of the Mantanuska and Bering coal fields he says: "*The high character of the coal from both of these fields, much of it approaching anthracite in quality, is vouched for by many reports from the Geological Department of the Government * * *. At the present time, with mountains of high-grade coal within 100 miles of the coast, the coal used in Alaska is brought from British Columbia and Australia, and no Alaskan coal is to be had. British Columbia coal brings $8 per ton on the dock at Juneau, and it is claimed that good Alaskan coal of equal or superior quality could be laid down on the same dock at from $5 to $6 per ton.*"

While Mr. Mann in his report rightly states that the past action of the Government in reference to these coal fields was *reservation* and not *conservation*, and rational steps should be taken to develop them and make the coal available for markets where it is needed, he shows by his language, "mountains of high-grade coal," that he is not familiar with coal geology or coal mining. His statement as to the high character of the coal is also so misleading as to be a serious misstatement. There is *some* good coal in the fields mentioned, but both fields are so disturbed and faulted, and there is so much inferior and worthless matter in the coal seams in many localities as to make the problem of mining the pockets of good coal in a profitable manner a difficult one.

The reports of William Griffith, the widely known coal geologist of Scranton, Pa.; of George Watkin Evans, mining engineer and geologist, formerly in charge of the Coal Surveys in the Washington Geological Survey; and of Prof. W. R. Crane, of the Pennsylvania State College; all of whom made separate investigations and reports on Alaskan coal, show actual conditions. These reports can be verified by competent men in the service of the United States Geological Survey. No one of the three gentlemen mentioned consulted with the others, and all made their investigations and reports individually. When the difficulties of the work involved are considered, the three reports are remarkable for their close corroboration of each other, and all have been published in full or in part in The Colliery Engineer.

With such information as is given in the three reports last mentioned, Congress can frame and pass such legislation as will be of real value in developing and utilizing Alaska coal. But if legislation is to be framed with the idea that the Alaskan coal fields consist of "mountains of high-grade coal," such legislation will not only be foolish, but will be disastrous to the territory and injurious to the consumers in markets open to Alaska coal. Unfortunately too much National legislation affecting many industries, and the mining industry especially, is based on reports of special investigators who are not competent to intelligently investigate the matters under consideration.

Alaska needs railroads, and the coal fields should be developed. National legislation is required to bring about these results. Such legislation should be based on reports made by competent specialists, and not on those of men, like Mr. Mann, who in referring to the coal fields speak of "mountains of coal."

Unfair Criticism of Bureau of Mines

AT VARIOUS times the United States Bureau of Mines has been adversely criticized for making experiments that produced negative results. This has particularly been the case since the experiments made with Pennsylvania anthracite dust resulted in failures to produce explosions. These criticisms are unfair, and uncalled for. In many instances the proving of a negative fact is almost, if not quite, as important as proving a positive fact. Practically all anthracite mine managers and mining engineers knew from experience that Pennsylvania anthracite dust had never been exploded, but the public at large did not know it. The recent experiments made by the Bureau of Mines, at Pittsburg, Pa., have confirmed the opinions of the anthracite men, and the prominence given the results of the experiments has spread the knowledge throughout the world in an official and positive manner.

PERSONALS

James Anderson, chief mining engineer, of the Pacific Coast Coal Co., and recognized as one of the foremost coal experts on the Pacific Coast, died March 14, at his home in Seattle. Mr. Anderson had been ailing for more than a year.

Neil Robinson, of Charleston, W. Va., receiver for the LaFollette Coal, Iron and Railway Co., is formulating plans for its reorganization.

W. T. Hanlon, consulting engineer, of Cleveland, Ohio, visited and examined the properties of the Carbon Coal and Clay Co., at Bayne, Washington, during the month of March.

L. W. Davies has resigned as resident manager of the Hyde Coal Co., of Washington.

Charles Jones, general superintendent of the Roslyn Fuel Co., vis-

ited Pennsylvania during March and April.

George Watkin Evans, of Seattle, has been retained in a consulting capacity, by the Roslyn Fuel Co., and by the Carbon Hill Coal Co. He is also mining engineer for the Hyde Coal Co.

E. E. Kelsey has been appointed receiver for the J. M. C. Coal Co., operating mines near Oakland City, Ind., under a lease from the Peacock Coal Co.

H. J. Meehan has been appointed general manager of the Cambria Steel Co.'s mines at Johnstown, Pa.

At a meeting of the Board of Directors of the Davis Coal and Coke Co., Alfred W. Calloway was elected president of the company, in place of J. M. Fitzgerald, resigned.

Prof. H. H. Stoek, of the Department of Mining Engineering of the University of Illinois, recently delivered a course of three lectures at Rolla, Missouri, Lawrence, Kansas, and Ames, Iowa. The subjects of the lectures were the "Geography, Geology, and Properties of Anthracite"; "Mining and Preparation of Anthracite"; and the "Sociological Features of the Anthracite Industry."

George G. S. Lindsey, K. C., of Toronto, has been elected president of the Canadian Mining Institute for the coming year.

Albert E. Oliver, formerly superintendent of the National Fuel Co., at Bowen, Colo., has resigned to take charge of the Huerfano Coal Co., Walsenburg, Colo.

Edgar Connell, superintendent for the last 5 years of the Enterprise colliery, at Shamokin, Pa., operated by W. L. Connell, of Scranton, resigned on March 18, to enter the retail coal business. He will be succeeded by Alfred Hall, of Scranton.

Edward H. Coxe, of LaFollette, Tenn., has resigned as general manager of operations for Neil Robinson, receiver of the LaFollette Coal, Iron and Ry. Co., to take effect May 1. Mr. Coxe will be succeeded by George N. Shoemaker, now superintendent of the Rex No. 1 mine for the receiver. J. M. Page, who was for some months superintendent of Rex No. 2 mine, recently suspended, will succeed Mr. Shoemaker as superintendent of Rex No. 1 mine.

W. L. Morgan, formerly State Mine Inspector, Eighth District, East St. Louis, Ill., was appointed instructor in the Miners' and Mechanics' Institute, by Doctor James, president of the University of Illinois.

Patrick Quinn, superintendent of the Sunshine mines at South Fork, Pa., is to be head of the Sterling Coal Co.'s operations at Bakerton, to succeed the late John B. Reed.

Benjamin Reese, recently rounded out his 55th year of service in the mines. Starting at the age of 11 as a slate picker, he worked his way up to a mine foremanship, and is at present with the Cranberry colliery of A. Pardee & Co., at Hazleton, Pa., in that capacity.

J. E. Thropp, Jr., has resigned the position of general manager for Joseph E. Thropp, Everett, Pa., operator of blast furnaces at Everett and Saxton, and conducting coal and coke operations in Bedford and Huntington counties.

A. Beveridge, of Jenny Lind, Ark., has been appointed inspector of the Davis Coal and Coke Co., at Thomas, W. Va.

A. H. W. Johnson, president of the Pulsometer Steam Pump Co., died suddenly on March 16 last. William J. Berow, who has been identified with the company for many years, has been made manager.

Arthur Nealee, of Pittsburg, will become general manager for the Montour Coal Co., which has recently leased the mines of the Illinois Collieries Co.

Hon. John Munro Longyear addressed the graduating class of the Michigan College of Mines, at Houghton, on April 16. His subject was "Mining Coal Above the Arctic Circle."

C. L. Patterson, formerly superintendent of the Dearth plant of the H. C. Frick Coke Co., succeeded Robert Hogsett as superintendent at the Revere works of W. J. Rainey at Uledi, Pennsylvania.

Edward Devoy, president of the Devoy & Kuhn Coal and Coke Co., has retired, to engage in business for himself, with offices in St. Louis, Mo.

The Franklin Institute of Pennsylvania awarded H. H. Hirsch, of Philadelphia, the Edward Longstreth medal of merit in recognition of his miners' electric safety lamp.

James Martin, of the West Virginia State Department of Mines, has resigned his position to become general manager of the Paint Creek Collieries Co., at Mucklow.

Grenville Lewis, president and general manager of the Ideal Block Coal Co., of Lilly, Ky., has resigned. He will be succeeded by Edward H. Caxe, formerly of the LaFollette Coal, Iron and Railway Co.

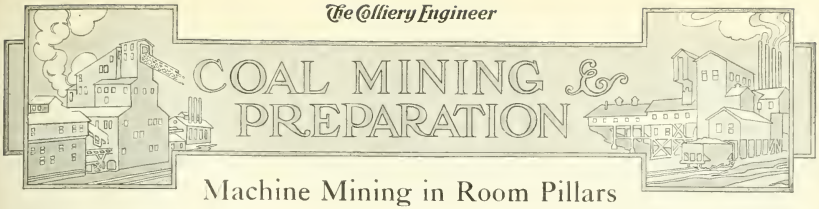
H. H. Pinckney, general superintendent of the Flat Top Coal Mining Co., has resigned to become general manager of the International Coal Co., at Bear Creek, Mont.

Not Spring Poetry

Spring is not an insignificant thing in astronomical mathematics. For instance, the earth has to swing around in its orbit 560,000,000 miles to reach from one spring to the next spring. Other brother planets in our solar system have to swing around an even larger orbit than our earth to reach their spring. The next planet to the earth, that is, Mars, swings around in 687 days, nearly a thousand million miles from one spring to another; while Neptune swings around over 18,000,000,000 miles from one Neptunic spring to the next Neptunic spring, which must be quite an event with the Neptunians.

Therefore, mathematically speaking, spring is a ponderously important matter, and not merely an "ethereal mildness" of do nothing and dream, but it is the time to clean up and start new improvements about the colliery.

The Colliery Engineer



Machine Mining in Room Pillars

Description of a New Method of Mining Which Recovers a Large Percentage of the Coal With Safety to the Mine and Men

By J. C. Edwards*

ONE of the serious problems that confront the mining man of today, is the necessity of devising a method of mining whereby a larger percentage of coal per acre can be extracted than was possible under the old methods of mining.

In the early history of the different mines, practically little or no attempt was made to recover the room pillars, halfhearted methods being the rule. Later on, after a more up-to-date method of mining had been adopted and the mining machine had come into more general use, a definite attempt was made to recover the pillar coal. This portion of the work, however, was done by the pick and met with more or less success.

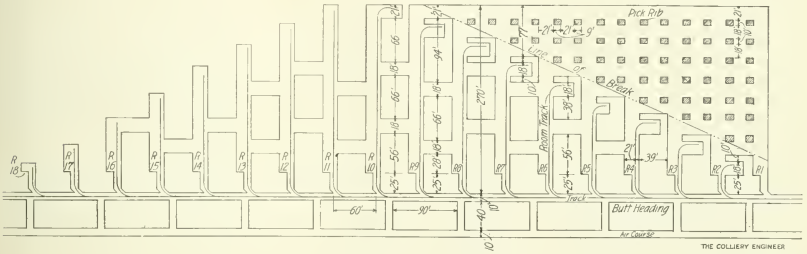


FIG. 1. EXTRACTING PILLARS UNDER DRAW SLATE

In this connection it is interesting to note the large percentage of coal that has been lost throughout the different mines. In glancing over the mine maps of the numerous mines in the bituminous region, it is surprising to note the amount of pillar coal lost, particularly in the earlier history of the mine. This enormous waste of the coal resources, was due entirely to the indifferent methods of mining in use at the time.

In many of the older mines no definite system or method of mining was adopted, other than the usual driving of face headings and butt rooms, definite projections of mine work being unthought of at the time. The face headings were driven on what was termed water level, and the butt rooms at right angles to the face headings; thus the room pillars became very irregular in thickness, the length of the rooms varied greatly, and where the course of the face headings changed enough to greatly increase the room lengths, considerable coal was left unmined between the room face and the face heading above. At a later period face headings were driven on a line at right angles to the pitch, and the butt rooms were also driven on line, thus insuring room pillars of more regular thickness.

In this method of mining, the butt rooms proved unsatisfactory and the face headings were then opened up about 1,000 feet apart, instead of 350 feet. Butt headings were driven at right angles to the face headings and continued to the air-course above and, in turn, rooms driven on the face of the coal were opened up from the butt headings. This method gave better results in the matter of haulage, and also afforded much better conditions for the miner.

It is interesting to note the conditions that led to the gradual change from the pick method of mining of years ago, to the machine method of mining today.

At the present time in all so-called up-to-date mines, the headings and rooms are mined by machines; with the pillar coal, however, it is a different proposition. In most mines these pillars are still mined by the pick. The general method is, after a room is driven to its destination, a cross-cut is opened up at the face and driven across to the adjoining room. From this point the rib is brought back from the entry break.

*Marianna, Pa.
34-10—3

In this method the pillars are not over 18 feet thick, as this constitutes the limit for a miner to shovel his coal, where no extra track is laid. In some of the mines, however, the following method was used: After the room had reached its destination, a slab was taken off the straight rib, and undercut by the machine, starting at the face and working back as far as the method allowed. This still leaves the largest percentage of the pillar coal to be recovered by the pick and ofttimes the remaining pillar is lost entirely.

In attempting to extract the room and entry pillars by pick work, the operators find themselves seriously handicapped by the fact, that about 89 per cent. of the bituminous miners in this region, except in those mines fronting on the different rivers, are of foreign birth and as a whole are far inferior to the English, Welsh, Scotch, Irish and German miners of years ago. There are very few of them that can do any real pick mining successfully. The majority of them are unskilled in mining as to method and are careless to a degree that they cannot be counted as a factor in recovering room and entry pillars. When placed at this class of work, I have noticed in numerous instances, that they fail to remove all the coal, leaving small pillars of coal intact. They are also careless as to their method of posting for self-protection and the proper mining of the coal, with the result that large portions of the pillars are entirely lost.

The conditions of the coal market from year to year have a tendency to demand a greater amount of lump coal. This, coupled with the facts of inefficient pick miners and the economy of the machine-mined coal, has drawn the attention of the operators to the possibility of successfully mining the room and entry pillars with machines. In the last few years an attempt has been made along these lines.

At the present time all of the larger coal companies have either adopted or are seriously considering methods for complete machine mining of their coal properties.

In this district the agreement with the United Mine Workers of America prohibits the use of the chain-breast machine and particularly specifies the shortwall machine, as the one to be used if any attempt is made to mine the pillar coal by machines.

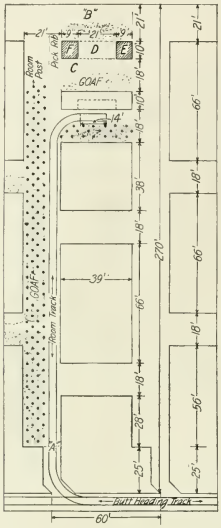


Fig. 2

A few of the companies, who own mines where in the early history of the mine about 50 per cent. of the coal was lost in the shape of room and entry pillars, have been experimenting with the shortwall machine in these old pillars, and are meeting with more success than was expected under the conditions. In fact the success has been so convincing that the companies in question are now beginning to use a method of mining adapted to the use of the chain machine in pillar work.

About a year and a half ago, while down at one of our Ohio mines, the writer was asked to make an attempt at recovering the entry stumps and chain pillars with a chain machine, so as to ascertain the possibilities of the chain machine in this class of work.

We went into an old heading, that had been abandoned for a period of 3 years, and started at the face with a chain breast machine. The first attempt was made in the chain pillar, and after removing this successfully, we decided to make an attempt to include the entry stumps on the next chain pillar. These we also successfully removed, although we were handicapped in the use of the breast machine, inasmuch as the first cut had to be made by the pick; this too, in a mine located in a section were pillars were never known to be recovered, even with the pick, as the conditions were considered too hazardous for pillar work. In this work we proved conclusively that, with a shortwall manchine and the proper method of mining, the room and entry pillars can be successfully recovered.

In applying methods to the mining of room and entry pillars with the shortwall machine, there are two general conditions to be considered:

First. That of a mine where draw slate is encountered.

Second. That of a mine where there is no draw slate to contend with.

The accompanying drawings show in detail the writer's ideas relative to the recovery of the room pillars under the two conditions.

Recovering Room Pillars Where Draw Slate is Encountered.—Fig. 1 shows the general plan of the rooms and the general scheme of recovering the room pillars. The rooms are driven on the face of the coal on 60-foot centers and 270 feet long. The neck is 25 feet from rib to rib. The room is widened out on one side to 21 feet, leaving a 39-foot pillar. The cross-cuts are offset as shown, and are 18 feet wide, except the one at the face of the room, which is 21 feet wide. Room 1 is shown as finished. In rooms 2 to 9, inclusive, the pillars are being drawn. Room 10 has reached its destination, and

the cross-cut at the face is being driven through the pillar to room 9. Rooms 11 to 18, inclusive, are shown as being opened up. The 9′ × 10′ hatched blocks denote the amount of coal left by the machines to be removed by the pick.

the cross-cut *B*, the two curve rails and two 14-foot sections of the room track are detached, and a cut is taken out of the pillar, as at *C*, working on the butt of the coal. This leaves a 10-foot pillar *D*. This cut, made 18 feet wide, is driven the

the room face. A cut 21 feet wide is next made through the 10′ × 39′ pillar *D*, cutting into the gob above, leaving a 9′ × 10′ block of coal or stump pillar at each side of the cut. This is to be mined with the pick. After the 9′ × 10′ block *E*, has been

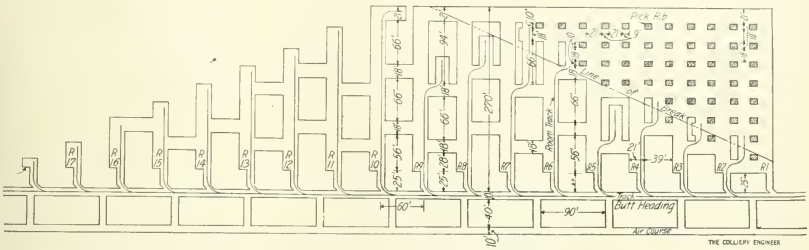


Fig. 3. Extracting Pillars Where There is No Draw Slate

Fig. 2 shows the method in detail of recovering the pillars by the shortwall machine, where draw slate is encountered. The room is opened at right angles to the butt heading and driven 10 feet wide to the point marked *A*, a distance of 25 feet. At this point the room is widened out on the left to 21 feet and driven this width to its destination, or a total distance of 270 feet from the butt heading. The 18-foot cross-cuts are opened up on the straight rib, at their respective distances as shown in Fig. 1. After the room has reached its destination, a 21-foot cross-cut *B* is driven through the straight rib to the adjoining room.

The track throughout the room is laid along the straight rib and the draw slate is gobbed on the side in which the room has been widened out. The system of posting may vary, according to the local conditions to be met with. The system as shown here, is known as the five-spot system. The track is standardized from point *A*, being laid in 14-foot sections from this point, and joined together with steel ties. The rails are joined together with half-splice bars. In this way the track is easily assembled or detached. Two standard curve rails are used in the same way, so as to have easy access to the cross-cuts. After finishing

length of the pillar (39 feet), thus leaving a pillar 10 feet wide and 39 feet long. The draw slate from the first cut is gobbed in the room proper; the balance of the draw slate from this cross-cut is gobbed on the rib toward the butt heading and the track is on the rib toward

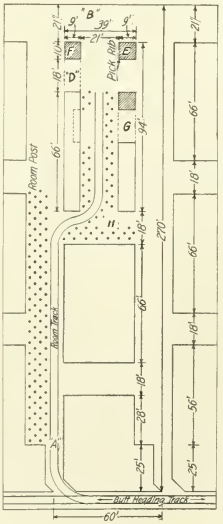


Fig. 4

removed by the pick, all the tracks in the cross-cut except the two curve rails, are removed. When the block *F* has been removed, the curve rails together with two more 14-foot sections of track are removed, and the operation of driving through the pillar is repeated until the room pillars are extracted as far back as the point marked *A*.

The tracks in all the rooms are in 14-foot sections, so that by removing two curve rails and two sections previous to making the first cut in the pillars, the tracks are always in the proper position. In cases where the coal cutting is done by compressed-air machines, the pipe lines are standardized in 28-foot sections or lengths, tees with one end plugged being used for jointing. By removing one section of pipe line for every two sections of track, the machine runner always has the proper convenience for cutting in the pillars.

The success of pillar drawing depends greatly upon the regularity with which the ribs are worked and the care taken to remove them clean. In Fig. 1, rooms 2 to 9, inclusive, are working on ribs; none of the ribs should remain idle. If the miner in any of these ribs is idle, a man from any of the rooms from 11 to 18 should be placed in

the idle man's place, until such time as the regular man returns to work, thus insuring regularity. Particular attention should be paid to the 9′ × 10′ blocks or stump pillars, so that they are gotten out clean. If the conditions are such, from roof pressure, that it is impossible to recover all of the pick rib, it should be shot down at all hazards and left lay. The removal of the posts also requires attention, so that they are properly removed. It may be necessary, in some instances to adopt the longwall method of setting posts, that of cutting a hole in the bottom and filling it with fine coal and placing a cap piece on top of it and then setting the post on the cap piece. However, local conditions govern this part of the work.

Fig. 3 shows the general plan of rooms and general method of extracting the pillars, where there is no draw slate to contend with. The rooms and track are the same as shown on Fig. 1, and differ only in method of attacking the pillars. Fig. 4 shows the scheme in detail. After the room is finished and the cross-cut *B* has been completed, the two curve rails and seven sections of track are detached. This leaves the track in position to be quickly assembled for easy access to the cross-cut *H*.

After assembling the track the 39′ × 94′ room pillar is attacked by driving a 21-foot place from cross-cut *H* to cross-cut *B*, leaving a 9′ × 94′ pillar of coal on each side. Next an 18-foot cross-cut *D* is driven through the 9′ × 94′ pillar on the rib nearest the face heading, leaving a stump pillar of 9 ft. × 10 ft., to be removed by the pick. The other 9′ × 94′ pillar is worked the same way, and this method is repeated until the whole pillar, 39 ft. × 94 ft., has been removed. Then the whole operation is repeated in the next pillar. In each instance the track is laid in the center of the working place in the pillar.

The entry stumps and chain pillars of the butt headings are won in the same manner as that used in the case of the room pillars. Both of these methods are in use at the several mines and are meeting with success.

Under normal conditions these methods can be carried out in detail as described. However, where other normal conditions exist, the room widths, lengths, and size of pick blocks or stump pillars may necessarily be changed in order to meet the conditions. In both of these methods 90 per cent. of the room coal is won by the machines. This can be increased considerably as it has actually been demonstrated that under favorable conditions part of the pick blocks can be recovered by the machine, the whole idea being to reduce the pick work to a minimum.

During my early career as a mining engineer I was present at a meeting of the local company officials, who had under discussion the length and width of the rooms, and, in particular, the width of the room pillar. After numerous arguments as to the advantages and disadvantages of the different widths suggested, an old practical miner who had taken no part in the discussion whatever, was asked what width, in his opinion, the room pillars should be. After carefully removing a clay pipe from his mouth, he replied: "If you leave enough of it there, you will always be able to get it when you want it." The remark made a deep impression on me at the time and later on I adopted the following rule: Always make a pillar large enough so that it may be split and you will be more successful in recovering it.

This thought is the basis of the methods which I have just described. Note that one-third of the coal is mined out in the shape of rooms and two-thirds in room pillars. Where the draw slate is encountered, the 39′ × 10′ stump pillar, and where the draw slate is not a factor, the two stump pillars of 9 ft. × 94 ft., together with the posting, will always afford ample protection to the miner.

Coal Mining Institute of America

The regular meeting of the Executive Board of the Coal Mining Institute of America was held in Pittsburg, Pa., January 8, and the following program was arranged for the summer meeting to be held on June 16 and 17, at Monongahela, Pa.

Local committee on arrangements at Monongahela: Alex. McCanch, chairman, William Bird, Henry Loutitt, H. T. Booker, and W. A. Luce.

First day, morning session, 10 A. M.: Address of welcome; address on "Lake Erie and Ohio River Ship Canal" (President Johnston to secure speaker).

Afternoon session, paper, "Mine Timber," (*a*) "Method of Timbering and Quality of Timber," by A. J. M. Armstrong; (*b*) "Method of Timbering With Reference to Overlying Strata and Geological Formation," by Wm. Seddon; (*c*) "Possible Substitutes for Mine Posts," by U. S. Bureau of Mines representative.

Evening session, in charge of local committee, arrangements for entertainment or otherwise as they desire.

Stereopticon presentation of timbering by representative of Frick Coke Co.

Second day, morning session, paper, "Accidents Caused by Machine Mining as Against Pick Mining," by A. P. Cameron; Question Box, conducted by W. E. Fohl.

Afternoon session, paper, "Practical Results from Efficiency Methods in Mining."

卒 卒

The following was found on the bulletin board where machine runners mark up their troubles, at a certain coal mine: "No. 4 Masheen awl Shot tu hel. Chain brok. fix the dam thing. it brok twist Last nite. needs new rearstaff leaver for the resisting box. amatoor smokes like heltoo. Power bad. lots of short circles. this is the masheen with self compeller truck. Wer outa oil tu."—*Compressed Air.*

Opening Nova Scotia Coal Mines

The Development of Mines of the Cape Breton Coal Field From Small Operations Near the Shore, to Large Mines with Railroads

By C. M. Odell*

THE coal fields of Cape Breton, situated on the northeast coast of the island, are largely submarine, and are divided into four basins known as the Morien, Glace Bay, Lingan, and Sydney mines basin, each being separated from its neighbor on the land areas by a well-defined anticline.

Map of Lingan Coal Basin, Cape Breton, N. S.

Whether all these basins join into one great one far out at sea, or end as separate basins, must be left for future workers to determine. Historical records show that the value of these coal beds was known and some coal exported during the French occupation in the first decades of the eighteenth century.

The earliest mining operations were carried on by driving tunnels into the seams where exposed in the cliffs along the sea coast, or in gullies where the age-long action of streams had cut through the various strata, leaving them exposed on either side. Coal extracted at this time was generally loaded on scows and then transferred to the vessel's hold. In the early sixties of the past century a number of small companies were formed and operations commenced at different points.

The system pursued by the small individual operators of these mines was to select a point as near the sea coast as practicable. There a mine was opened either by shaft or slope as the natural conditions best lent themselves thereto, and on account of the proximity of the shipping pier the coal was conveyed to the point of shipment direct in the mine car. The distance in most cases being less than a mile, the transportation was effected by horses. Gradually the mining was extended and with increased shipments sinkings were made further back from the coast, machinery for handling coal in larger quantities was installed, short lines of steam railway were built, and the coal at the pit mouth was transferred from the mine car to railway cars and thus carried to a point of shipment. It may be of interest to note the gradual expansion in size of cars used in hauling coal from the mines. Up to the early eighties the 4-ton car was almost universal in Cape Breton. During the next few years cars carrying 6 tons were introduced. These in turn gave place to 10-ton cars, which were the standard of the larger collieries only, up to the advent of the Dominion Coal Co., in 1893, when cars carrying 15 tons each were substituted. These in turn are gradually giving way to steel cars having a capacity of 35 tons of coal. In the same way, the 10-ton schooner has by successive stages been supplanted by the great ocean freighter of 10,000 tons carrying capacity.

The Dominion Coal Co. controls by lease from the Nova Scotia government all the coal areas worth considering on the southern side of Sydney harbor, but has for some years confined its operations to the Glace Bay Basin. A royalty of 12½ cents per ton is paid on all coal marketed, and this forms the greater part of the revenue of the province of Nova Scotia. A steadily increasing market has demanded a larger supply, and the company has now turned its attention to the immense

*Paper read before The Canadian Society of Civil Engineers, January, 1914, under title of "Initial Proceedings in Opening Up a Coal Mine."

reserve fields of Lingan and Morien basins. Both of these areas were worked to a certain extent some years ago. The Morien Basin by two companies—the Block House and the Gowrie—while the Lingan Basin was opened at three points

Dominion, No. 16, Colliery. Output 1,200 Tons Per Day

by the Low Point, Barrasois, and Lingan Mining Co.

The Block House Co., with openings close to the shore, shipped direct in mine cars to the vessel's hold, over a small shipping pier in Morien Bay, while the Gowrie company sank a shaft about a mile and a half inland, which was connected with a shipping pier by railway. Coal from the Lingan Basin was shipped partly in Sydney harbor which was reached by 4 miles of railway, and partly in Lingan Basin where small piers were erected and connected with the mines by a mile of railway.

All of these individual operations were absorbed by the Dominion Coal Co., at its formation in 1893, many of them having been closed down for years before this date, and their piers allowed to fall into decay. The policy pursued by the present operators has been to concentrate their energies on the Glace Bay Basin for production, and to confine the shipping mainly to Sydney and Louisburg harbors, where modern piers capable of handling all the product have been erected. Two points of shipment were necessary for the reason that the magnificent harbor of Sydney, lying within 14 miles of the mines and offering unsurpassed facilities for shipment, is frozen over during part of the year, while Louisburg harbor, some 25 miles distant in the opposite direction, is open the whole year round and furnishes an outlet when Sydney is closed. Another small shipping pier at Glace Bay harbor supplies the smaller vessels frequenting this port. This is maintained more as a convenience to such shipping as discharges cargo in Glace Bay and could not at times make Sydney harbor in safety without taking in ballast.

The bulk of the output is shipped at Sydney where the tonnage during summer months is such that the output is removed as fast as it is sent from the collieries. At Louisburg, which is utilized during winter months, the same regular supply of shipping cannot with certainty be counted on, and consequently a large storage pocket with belt conveyer system is resorted to. Any overplus of coal raised during winter months is stored in coal bank and removed in summer when the St. Lawrence trade taxes every source of supply to the utmost.

This involves the construction of a branch line of railway, connecting each new colliery with the main line, and a colliery railway yard near the pit mouth for the handling and sorting of the various grades of coal. The expenditure necessary to place in full operation a colliery in virgin territory is in round numbers about $750,000, and may be generally divided as follows:

	Per Cent.	
Purchase of site	2	$ 15,000
Prospecting and temporary work	2	15,000
Railway construction	12	90,000
Permanent bankhead, colliery buildings, and operating machinery	33	247,500
Lighting	2	15,000
Water supply	5	37,500
Drainage and grading	2	15,000
Housing employes	22	165,000
Fire and life saving stations	2	15,000
Shipping facilities	7	52,500
Underground development, including tracks, mine cars, piping, and mine machinery	11	82,500
	100	$750,000

Reference to the map will show that the known coal seams of the Lingan Basin extend from Sydney harbor on the north to Lingan Bay on the south, a distance of about 5 miles, and extending some 2 miles inland, embracing an area of 10 square miles of land and about 10 square miles of submarine.

The general dip is northeasterly and the angle of dip about 14 degrees in the center of the basin, decreasing toward the south and increasing as the seams are followed northerly to where they disappear under the waters of Sydney harbor, where the dip has increased sharply until an angle of 40 degrees has been attained.

The plans of the company comprise the opening in the near future of eight collieries in this basin, four each on Victoria and Lingan seams. Four of these, numbered 12, 14, 15, and 16, are practically complete; producing 1,200 or more tons daily, and a fifth is in process of development. Plans are maturing for the opening of two more at the extreme southern end, and a similar one on the extreme northern end of the field. This

Dominion, No. 14, Colliery. Output 1,600 Tons Per Day

will exhaust the operations on the Victoria and Lingan seams, and leave future enlargement of production to the Barrasois seam, which is the uppermost of the series, and the Mullins seam, which is the lowest of this group and consequently the largest in superficial extent. When these last seams are developed to their capacity, five more mines will have been added to the operations in the Lingan Basin, making thirteen mines in an area of 10 square miles.

The various openings are made along the outcrop of the seams at intervals of about a mile and a quarter apart. The deep or main slope is then driven on the dip of the seam and from this the levels are turned at intervals of 500 to 600 feet. These levels are to be extended half a mile on either side of the slope, at which point a solid barrier of coal parallel to the slope will be left. The barriers will extend from the surface to the extreme depth of the collieries, and are designed to separate each mine from its neighbor, so that in case of flood or fire, a stoppage of one mine need not affect the adjoining operations. Only a basin of such marked regularity in dip and position of the various seams comprising it would lend itself to such a system of working, and in this basin nature has left nothing to be desired. The coal collected from the various levels is drawn to the main slope, whence it is carried by a rope haulage system to the bankhead, there to be run over screens and picking belts into the railway cars for transportation to either of the railway terminals.

Records show an average of about 2.4 tons of coal raised per man employed, and the house record shows about 2.4 working men were housed per tenement. Hence a colliery of 1,200 tons daily production requires 500 men, and they in turn require 200 tenements. The old time "miners' rows" have been long since tabooed and today the company erects neat cottages which are let to the men at reasonable rates. The most suitable style of tenement seems to be a good class of double house, set on a large lot of land, and the grounds around many of the miners' houses today present a neat and attractive appearance. These houses are erected and owned by the company. Their cost at present date averages about $1,500 to $2,000 per double block, exclusive of land. As they occupy extra lots and are built on wide streets, they average but four to an acre, hence about 25 acres of land per colliery is required for housing alone. Adding 125 acres for colliery buildings, railways, roads, pole lines, pipe lines, and drainage ditches, an average of about 150 acres per colliery is required for surface rights, or about 2,000 acres for a layout such as is undertaken here.

The lands surrounding the houses are for the most part owned by the company, and are all laid out and the streets graded by the company's engineers. In quite a few cases the miners buy land and build their own houses, and this custom will no doubt increase as the whole section becomes more settled. The company encourages the men to become their own landlords, and assists them pecuniarily in many cases.

About 2½ miles of standard-gauge track is required for colliery yard at each bankhead, with an additional amount of branch line to reach the main railway, making an average of about five miles of track to be laid for each colliery opened. This track is all laid with 60-pound rails, while the main line, which is subjected to heavier traffic, is laid with 80-pound rails. All tracks are built in latest approved manner, as nothing less would suffice for the enormous and ever-increasing traffic.

As development proceeds and output increases, larger expenditures become necessary for increased screening appliances and picking belts by which the various grades of coal are sorted and impurities removed. More recently a coal washery was demanded through which the lower grades of coal are passed to more effectually remove sulphur

Dominion, No. 15, Colliery. Output 1,000 Tons Per Day. Electrically Operated

and other objectionable materials. To this end the company has erected a large coal washer of the Baum type, claimed to be the best in the world, and capable of washing 120 tons of coal per hour.

As a matter of economy the refuse from the picking belts and the slack coal from the screens is used under boilers for power raising. A great change has been effected in recent years by the introduction of electric power in place of steam, and the tendency now is to eliminate all steam around the collieries of the Lingan Basin, except for heating purposes. Up to this year these collieries have been supplied with electric power from a generating station located in the center of the Glace Bay Basin some 8 miles distant, but as a part of the equipment a larger generating station situated in the heart of the Lingan district is now nearing completion. This station is to be operated by turbine-driven generators of from 2,000 to 4,000 kilowatt capacity. The boiler plant consists of three Bettington boilers, a description of which was published in the *Canadian Mining Journal*, in September last. When completed the entire equipment of this district, including air compressors, coal hoists, ventilating fans, bankhead machinery, screening plant, and underground pumps will all be electrically operated.

In the matter of protection for men and property under ground, the Draeger life-saving apparatus has been adopted, and the erection of a life-saving station at each mining center is deemed a necessary portion of the general equipment.

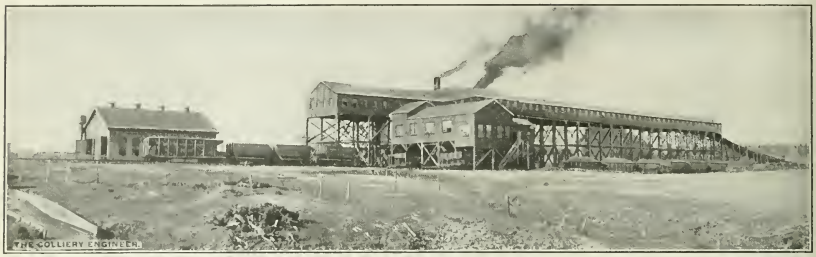
Water supply is always one of the very first requisites, and at present a temporary pumping plant at Waterford Lake supplies the needs of the community through a main and distributing system. Plans are however about perfected for a full and ample supply to the whole community at an estimated cost of $250,000.

Surface workings of all collieries are electrically lighted from the company's plant, and some street lighting is also done. At present the townsite known as New Waterford, is unincorporated and practically all street work, drainage and sewerage is undertaken by the company. Mine drainage is effected by pumping plants located near the seashore, water being forced through vertical bore holes by electrically driven underground pumps and carried by surface ditches to the sea.

Shipping piers with all modern appliances are located in Louisburg and Sydney harbors, the average haul from pit mouth to shipping pier being about 20 miles. Locomotives of 120 tons weight, with coal hoppers of two different types are used on all lines, the two types being wooden hoppers of 15 tons carrying capacity, and steel hoppers of 35 tons capacity. In addition a small percentage of coal which is shipped by rail is carried in box cars. To accommodate these, special box-car loaders are installed at some of the collieries, as the loading appliances for hopper cars would not answer for the side doors of the box cars. Present pier-loading capacity is about 1,600 tons per hour, but the new pier which is nearing completion, will greatly increase this.

Coal carrying steamers have been gradually increased in capacity from the 3,000-ton ship which was looked upon as a leviathan some 20 years ago, to vessels of 10,000 tons capacity in use today. These will again be displaced by ships of still greater burden as years go by.

Even with the colliery fully equipped and producing to its full capacity, expenditure on capital account cannot be said to have ceased entirely, as with the workings extending farther and farther to the deep, increased pumping and ventilating capacity become necessary, the increased length of mine tracks and air piping add to their quota, and additional mine cars and mining machines are required to gather a given quantity of coal over a greater area.



Dominion, No. 12, Colliery. Output 1,400 Tons Per Day

Coal Field History

Texas coal mining dates from 1884, when 125,000 short tons were produced. In 1912, about 2,100,000 short tons were produced. The Pocahontas Flat Top field commenced operations in 1883, shipping 60,828 tons of coal and 19,805 tons of coke. In 1912, Pocahontas shipped 13,497,604 tons of coal, and 1,161,662 tons of coke.

Belgian Coal-Dust Precautions

Methods Employed for the Prevention of Coal-Dust Explosions in the Mines of Belgium

By Victor Watteyne*

THE danger arising from the coal dust in mines was proved beyond a doubt in Belgium, by the serious mining disaster that occurred in the La Boule mine at Quaregnon, March 4, 1887, causing 113 deaths.

In *Annales des Mines de Belgique*† this explosion, which I had the opportunity to study very minutely, was described.

My convictions relative to dust explosions were formed at that time, and since then I have expressed them in many publications‡. Although I was personally convinced of the danger resulting from dust, most of the engineers in Belgium as well as in France, remained skeptical, and it took the awful disaster of March 10, 1906, at Courrières, to open their eyes.

However, the danger was not altogether disregarded in Belgium. In some places, the engineers' attention was called to the dust as having been the primordial cause of the explosion, or oftener, as having acted as an agent for its propagation. It also often happened that, after accidents, dust was made responsible before the Court, by some mine workers, who sought to place the blame on the dust, to defend themselves for having committed some imprudence in connection with firedamp.

Besides, the dust danger was the cause of some official directions:

In January, 1880, the late Gve. Arnould, at that time, director of the First Mining Section at Mons, had the following notice posted at those collieries where firedamp was to be found:

"In order to avoid, as much as possible, the ignition of the fine coal dust in an atmosphere liable to be more or less charged with firedamp, it is advisable to sprinkle the walls, woodwork, and floors of the entries.

"When blasts are fired, this precaution is especially important. I, therefore, recommend sprinkling at working faces, where dust is plentiful and dry."

Two years later, October 7, 1882, during the deliberations of the Belgian Firedamp Commission, the Minister of the Interior issued a circular intended to call the attention of mine workers to the various precautions to be taken when using explosives. This circular contained the following lines:

"For some years, the part played by coal dust in coal mine accidents has been investigated and different opinions derived.

"While waiting for new experiments to settle the question, it is not advisable to fire blasts in the places where dust is abundant, dry, and fine, before having sprinkled and swept the floor, the woodwork and the walls of the entry about the shot hole.

"This precaution is especially recommended, when the shot hole has been tamped at the level of the floor where the miner will have to be careful to avoid blown-out shots.

"It will also be wise to avoid, in the vicinity of the blasts, during the time of the firing, all kinds of operations like dumping or loading that are liable to produce dense clouds of dust which might be carried in the direction of the holes. It is also to be considered that, with fresh friable coal, in which firedamp is to be found, an operation of this kind, besides causing the formation of dust, may also cause an emission of gas.

"The application of these precautions will depend on the degree of inflammability of the dust and on the quantity of firedamp to be found in the seam . . ."

These directions were soon disregarded and were never enforced in most of the mining districts.

However, in the "Couchant de Mons," the precaution of sprinkling before firing blasts was, and still is, ordered as an imperative condition in order to get authorization to use explosives that otherwise would be forbidden by the regulations.

The Regulations of 1895 concerning the use of the explosives, point out the danger of the dust by prescribing, Article 13:

" . . . the use of explosives in the mines where firedamp is to be found, is subject to the following conditions: To fire the blasts, only after being positively satisfied, by an inspection of the flame of the lamps, that there is no firedamp in the air surrounding the hole, that no trace of it comes out of the hole and, that, even beyond the distance that may be affected by the effects of the firing of the blast, there is no inflammable gas, no crack in the ground from which some may come out; and besides, only after having made sure that in the surroundings of the blast, as designated above, there is no dry, fine and inflammable dust, floating in the atmosphere, or deposited on the ground, on the woodwork or on the walls that the blast could put in motion . . ."

There are two ways of combating the danger of dust, which can be used also simultaneously. They are:

1. To suppress the dust or to render it harmless.

2. To suppress any flames that are liable to ignite the dust.

The most important means of the first class are the sprinkling with water and the schistification, or stone-dust treatment.

Neither of them has been, so far, extensively used in Belgium.

General sprinkling, that is, sprinkling adapted to all the working faces

*Inspector General of Mines, and Chief of Board of Mining and Gas Accidents of Belgium. Translated from the French by A. Courtin, B. A. and B. S.

†"Comparative Examination of Two Great Explosions, Courrières and La Boule," *Annales des Mines de Belgique*, Vol. XII (1908).

‡See among others: "Dust Explosions," *Revue Générale*, March, 1889. "Means in Use to Fight Dust Explosions," *Annales de Travaux publics*, 1890. "The Dust Question Before the English Commission." *Revue Universelle des Mines*, 1893. "The Cameron Explosion," *Annales des Travaux publics*, 1894, etc.

by means of a special piping or of any other contrivance furnishing methodical sprinkling, is used nowhere.

In Belgium, where many shafts are from 800 to 1,200 meters deep, the temperature is high, the pressure of the ground is considerable, the beds are comparatively thin and irregular, and where the working faces are far apart, the difficulties in applying sprinkling are especially great and the inconveniences resulting from them serious and numerous.

Not so, however with local sprinkling in the immediate vicinity of the hole, before firing the blast. This kind of sprinkling is, as stated, sometimes used in the mining districts.

If the methods of the first class are little used for the suppression of dust in Belgium, those of the second class, or the methods calculated to suppress all flames liable to ignite the dust . . . and the firedamp are much used.

The direct cause, most frequent in igniting dust, is the use of explosives.

I said "the direct cause," because explosions of dust can be generated by a previous ignition of the firedamp, caused by a lamp, for instance, but the possibility of ignition through this agent is lessened, in Belgium, by the imperative use of safety lamps in all parts of the mine, as soon as any trace of firedamp, no matter how slight it may be, is detected.

Before being adopted, all safety lamps are subjected to exhaustive tests at the Experimental Station at Frameries, to demonstrate their safety.

The electrical apparatuses in use in collieries in Belgium are installed in such a way that no spark can strike the atmosphere of the mine. The traction by means of trolleys is not used.

The Department of Mining and Firedamp Accidents has especially directed its efforts in its work at the Experimental Station of Frameries, as well as in the studies previous to it, toward fighting the cause of ignition coming from explosives, which constituted formerly, in Belgium, the most frequent cause of explosions of firedamp and dust.

At first it was tried to limit to a great extent the use of explosives. In the regulations of December 13, 1895, the use of explosives is forbidden, except in case of a special authorization, in the mines containing firedamp, not only for the breaking down coal, but also in many cases for driving the entries.

The use of explosives was entirely suppressed in some collieries. However, it was soon realized that not very much could be done without them because with the thin beds (less than .3 meter) worked in Belgium, the suppression of explosives in enlarging the entries was equivalent, in many cases, to the abandonment of the work.

Under these conditions, consideration was given to so-called safety explosives. The history of these explosives is so well known it need not be repeated.

In 1899, in the *Annales des Mines de Belgique* and again the following year, at the Congress of the Mines in Paris, in 1900, Mr. Denoël and the writer expressed opinions on this subject and finally recommended the "Limit Charge," or maximum charge, as constituting the best criterion of the safety of the explosives, as it is the resultant of the numerous factors affecting this safety.

The Experimental Station of Frameries was created for this purpose.

As early as 1905, it was possible to give out a first list of explosives, of which the "limit charge" had been determined in respect to the firedamp, and in which this charge was powerful enough to satisfy the exigencies of practical work, the minimum charge being equivalent to 175 gramms of dynamite No. 1.*

Later on, we started again our experiments with the dust, and we found that several explosives that had given good results in case of firedamp were not safe with dust, or, under the new conditions had a smaller limit charge.

We were thus compelled, in 1909, to establish a new list of explosives in which limit charges were indicated both for firedamp and dust, and for this reason we named them explosives S. G. P. (Sûreté, Grisou, Poussières).†

The mine rules do not demand the exclusive use of these explosives, but advices and instructions from the Minister have recommended their use, even making it an essential condition for granting special privileges, which are comparatively frequent, on account of the strictness of the rules.

Under these conditions the mine owners, anxious for the security of their workmen, began to use safety explosives more and more, and the result was, that the Belgian mines, which used to be so often stricken by terrible disasters, are now remarkably safe in regard to explosions of firedamp and dust, because the cause of ignition is now practically suppressed.

These S. G. P. explosives are very closely watched, and tests of them occur frequently in order to avoid the existence of frauds or negligence in their manufacture that would impair the safety of the explosives.

As it may happen that, in spite of the tests, there is some disappointment concerning the real and unquestionable safety of the S. G. P. explosives, at the Frameries Experimental Station we looked for another device that would be added to the exclusive use of the safety explosives, and that would be safe enough itself to act alone if necessary.

We were thus brought to devise and experiment with what we called "outside tamping," the idea of which

*Watteyne and Stassart, "Safety Explosives at the Experimental Station of Frameries," *Annales des Mines de Belgique*, Vol. X, and Publications of the Congress of Liège, 1905.

†Watteyne and Stassart, "Mines and Explosives," at the Congress of Applied Chemistry, in London, 1809. Ann. M. B., Vol. XIV and Publications of the Congress of London.

is due to my coworker and assistant, Mr. Emm. Lemaire, chief engineer.

The experiments began in 1910 and were described in two publications in the *Annales des Mines de Belgique*, one in 1911 and the other in 1913.‡

It consists of accumulating before the opening of the shot hole a little heap of incombustible dust, held in position by a protuberance of the rock, or by a tube or a little platform made of wood, metal, or pasteboard, in fact, by any possible contrivance. The combustible cloud, stirred up by the blast, cools off and smothers the flames of the explosive, making them harmless.

The amount of incombustible dust to be used is dependent on the charge of the explosive and its weight must be 5 or 6 times that of the charge.

This extremely simple process gave remarkable results: The most dangerous explosives, fired with heavy charges without any other tamping, blowing out in the most inflammable atmospheres loaded with firedamp and dust, have not caused any ignition; the only condition to be fulfilled is that the quantity of incombustible dust used for the outside tamping be proportional to the charge as mentioned above.

It may be added that today our process is already in use in several mines of different European countries, following our first publication on the subject.

The "outside tamping" thus completes the means adopted to prevent the initial ignition, and doubtless the safest way to prevent a mining disaster is by stopping it at its very origin.

However, as too much security can never be had, we have been studying another device that is called "inside stone-dust treatment," consisting of a sheath or coat of incombustible dust or material that can be easily pulverized and placed in the shot hole. This process, that recalls the one known as the "water cartridge," experimented with previously, is giving good results today, but our experiments in this line are still incomplete.

Summing up, in Belgium, for a long time, and especially since the establishment of the Frameries Experimental Station, we have directed our efforts toward preventing the initial ignition of an atmosphere supposed to be inflammable on account of the firedamp or the dust or both combined.

The results obtained in regard to the security are encouraging. In spite of the difficult conditions found in our coal mines, that are the deepest among those of the entire world, containing the largest percentage of firedamp and presenting the most complicated seams, we have fewer accidents than other coal mining countries.

This was not the case 20 or 30 years ago, and some very suggestive tables on this matter give number of killed each year for 10,000 underground or surface workers. Table 1 refers to all mining accidents:

Table 1. Number Killed Per 10,000 Underground or Surface Workers

Period, 1881–1885	22.30
Period, 1886–1890	17.65
Period, 1891–1895	16.63
Period, 1896–1900	11.18
Period, 1900–1905	10.42
Period, 1906–1910	9.92

Table 2 gives the same figures for all accidents with firedamp and dust; it contains the cases of asphyxiation.

Table 2

Period, 1881–1890	4.87
Period, 1891–1900	2.80
Period, 1901–1910	.77

In Table 3 the explosions and ignitions only are considered. The decrease is still more marked.

Table 3

Period, 1881–1890	3.64
Period, 1891–1900	2.20
Period, 1901–1910	.36

If we should consider separately the period of the last five years, 1906-1910, the figure decreases to .16.

Finally, in the three years 1911, 1912, and 1913, only one man was killed on account of ignition of firedamp or dust, and this occurred through the gross negligence of the lamp tender, who forgot to place one of the metallic gauzes in fixing a safety lamp.

Although the situation could still be improved, we believe that we are justified in stating that, especially in connection with the danger of firedamp and dust, the results obtained in Belgium are highly encouraging.

‡See Watteyne and E. Lemaire, "The Outside Tamping with Incombustible Dust." Notes 1 and 2 An. M. B., Vol. XVI, 1911 and Vol. XVIII, 1913. See also The Colliery Engineer, Vol. XXXIV, p. 263.

Mine Inspectors' Institute

At a meeting held in Pittsburg, at which every inspector of the twenty-eight bituminous districts of Pennsylvania was present, a program for the entertainment of members of and visitors to the Mine Inspectors' Institute of the United States of America, was considered. The Institute is to meet in Pittsburg June 9 to 12.

The entertainment features are in charge of the bituminous inspectors of Pennsylvania, I. C. Roby, Uniontown, chairman. The guests on the evening of the opening day of the convention will be given a boat ride up the Monongahela River as far as McKeesport, then back to Coraopolis. A banquet will be arranged for the evening of June 10. There will be demonstrations at the testing station and at the Bruceton experimental mine by attaches of the United States Bureau of Mines. The complete program will be announced later. Some of the most notable men in the engineering and technical divisions of the mining industry will address the institute, of which David Roderick, of Hazleton, Pa., is president, and James W. Paul of the United States Bureau of Mines, of Pittsburg, is secretary.

Officers of the Bituminous Mine Inspectors' Association of the Pittsburg District are: President, Thomas K. Adams, Mercer; vice-president, I. C. Roby, Uniontown; secretary-treasurer, Thomas S. Lowther, Indiana.

There are approximately, 5,500 Magyar miners in the state of West Virginia.

Pond Creek Coal Co.

Operations near Stone, Pike County, Kentucky—Modern Plant with High-Class Equipment

By William Z. Price

NEAR Stone, Kentucky, 8 miles west of Williamson, W. Va., on a branch of the Norfolk & Western Railroad, the Pond Creek Coal Co. is developing 28,000 acres of coal land. Scattered over the territory under development are five seams varying from 3 feet 6 inches, to 6 feet 8 inches in thickness. At but one mine, however, the No. 2, are all the seams present. They are from the top down, known as the Borderland, Upper Thacker, Lower Thacker, Alma, and Freeburn. At present only the Freeburn seam is mined.

No. 3 Tipple and Power House, Pond Creek Coal Co.

Approach to No. 3 Tipple

The coal is of fair cleavage and free burning, its only impurity being a laminated section which although thrown out, will eventually be reclaimed, crushed, and burned under the boilers.

All the developments are recent, the Nos. 1 and 2 mines being started in February, 1912, at Hardy, a short distance east of Stone. The other openings followed in quick succession.

In the panel system of mining adopted, the four main entries, and the butt entries are driven on 40-foot centers, and the rooms on 42-foot centers. A barrier of 70 feet is allowed to remain between adjoining panels.

Eight mines have been opened, but the No. 4 is not working at present because of a fault. All of the tipples are built on the same plan, save those at No. 1 and No. 6 mines, where there is no screening or sizing, as "run of mine" only is shipped from those points. Nos. 7 and 8 mines feed into the same tipple.

At the tipples the loaded trip is pulled by a car haul up a short 4½-per-cent. grade. When a car has reached the top of the grade it is disengaged and then uncoupled, meanwhile another hook on the car haul has engaged an axle of the next car and the first car is pushed over the knuckle, and runs down a 4½-per-cent. grade for 8 feet, where it strikes a lever situated just inside the rail, this throws out the clutch of the car haul and the car runs for 17 feet down a 1½-per-cent. grade on to a Phillips cross-over dump. After the car is dumped, the tipple top man throws a lever near the dump which reengages the car haul clutch and the operation is repeated.

The coal drops into a hopper and then runs to a 1¼-inch bar screen, where the slack and nut falling through on to a ¾-inch bar screen, are separated into two sizes. The slack falling through the ¾-inch screen passes on to a Robins belt conveyer 28 inches in width, traveling at a speed of 445 feet per minute, which carries it to the opposite end of the tipple, where it falls on to a conveyer running at right angles to the first one, which delivers it to a storage bin. In case there is a demand for slack, a gate is raised near the end of the first conveyer and the coal drops into the next chute and thence into the railroad cars.

The nut coal goes from the ¾-inch screen on to a nut picking table 5 feet wide moving in the same direction as the belt conveyer, at a speed of 42 feet per minute. The lump coal passes over a similar table. Heyl-Patterson Co. supplied the tipple equipment. The power is supplied by Westinghouse induction motors.

The initial installation of mine cars for this company consisted of 800 composite cars, designed and built by the Hockensmith Wheel and Mine Car Co., and they incorporate a number of distinctive features.

The cars are of wood and steel construction, the bottoms are of 3-inch white oak planks and the sides of ¼-inch steel plates. These plates, instead of being one piece, and riveted to the binders in the customary manner, are made in three pieces and then bolted fast, following the same construction as used in wooden cars, except that steel is substituted. This construction admits of repairs being made with

the same rapidity as is the case with an all wooden construction. The limited facilities for repairing cars usually found at coal mines, practically preclude the repairing of the riveted type of car, which is one of the objections that have, in many instances, prevented their more general adoption.

The necessity for a swing door which can be automatically opened and closed, in preference to the lift type, has been recognized. The Correll latch with which these cars are equipped possesses advantages, in that there are no parts to get out of order and it is certain in its operation.

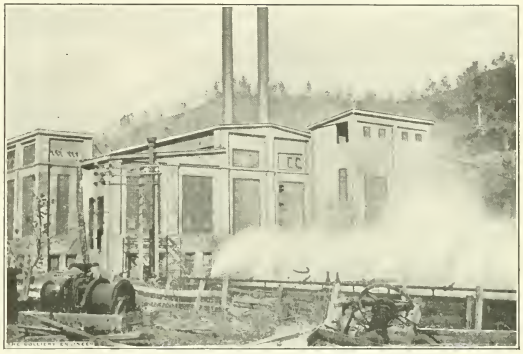
The wheels are 14 inches in diameter, with chilled treads and fitted with Hyatt steel rollers, 7 inches long. These rollers are so placed in the hubs that the center lines of the load and bearing coincide, resulting in a balanced bearing.

The angle bar truck construction is used on these cars. By means of the angles, the bottoms are supported; thus permitting the free rotation of the axles. The method of mounting the boxes on these angles insures absolute permanency of wheel base. All shocks are distributed through the truck and not taken up by any one part, as is often the case.

The bumpers are of heavy steel plate, formed to shape on a 40-inch radius. The single link type hitching is used, and a double roller brake is operated from the rear of the car.

The coal cutting machines in use are products of the Jeffrey and the Sullivan companies. Six-ton General Electric mine locomotives are used for gathering purposes and 15-ton for haulage work. The latter are specially constructed, being 34 inches over all in height.

The power house, 100 feet wide by 150 feet long, wherein the current for the tipple, mine locomotives, coal-cutting machines, etc., is generated, is built of concrete. On its western side is a pool 60 feet by 150 feet and 5 feet deep equipped with overhead sprays, which serve to cool the water used in condensing the engine steam. This pool is enclosed by concrete walls with openings 3 feet square at intervals along the creek side. These openings are closed with dry walls, which with the sand and gravel, filter the water flowing through from the creek. Water flows from the pool to the power house condenser through a small concrete tunnel, 3 feet wide and 4 feet high.



Power House and Condensing Apparatus, Pond Creek Coal Co.

In the power house the coal for the boilers drops from the railroad cars into a bin at the south side of the building. Under the bin is a bucket conveyer which elevates the coal to an overhead car, that travels the length of the boiler room and discharges the coal into chutes which lead to the coal boxes of the Jones underfeed stokers. This overhead car is equipped with scales for weighing the coal. To dispose of the ashes, a conveyer under the fireboxes of the boilers carries them to an elevator from which they are taken to a bin over the railroad track.

The boiler room is equipped with two 300-horsepower sets, each set having two Babcock & Wilcox water-tube boilers. Each set has an individual stack 60 inches in diameter and 125 feet high. The boilers were tested at 240 pounds pressure, although but 150 pounds is maintained. The boiler room still has space for another set.

Duplicate Blake boiler-feed pumps and one Cochran feedwater heater are located in the basement of the engine room. Expansion tube regulators are used on the pumps.

In the engine room the equipment consists of a Buckeye engine directly connected to a 2,300-volt, three-phase alternating-current generator, a 750-kilowatt mixed-pressure Curtis turbine, a Schutte and Koerting multijet condenser and a turbocentrifugal pump for condenser water supply.

The condenser discharges into a hotwell from which a motor-driven centrifugal takes water and forces it through the 3-inch sprays over the pool. When there is a good supply of water making it unnecessary to use the water again, the discharge from the condenser passes through a 20-inch tile under the floor into the creek below the power house. In this case, however, the spray pump is not run.

In the engine room, space is reserved for the future installation of another turbine and alternator. A DeLaval steam turbine-driven, and a motor-driven exciter are used. At one side of the engine room is an opening over the pit in the basement. While the pumps and their auxiliaries are under the care of an as-

sistant engineer or boiler-room man, they are under direct observation of the head engineer on watch at all times.

The water for domestic use and fire protection is obtained from two deep wells by means of an air lift to a sump from which it is pumped to a 250,000-gallon tank, by a Platt duplex steam pump. The tank is on a hill, 200 feet in elevation above the power house.

All plunger pumps in the power house are interconnected so that any one may perform the service of another in case of breakdown. The condenser also has a connection with the water main in order to tide over an accident that might happen to the condenser, without shutting down the plant.

Power is generated at 2,300 volts and stepped up at the plant through single-phase transformers to 11,000 volts for transmission lines. There are three transformers on each three-phase circuit, each protected by lightning arresters and disconnecting switches. A substation is installed at each mine, equipped with step-down transformers which change the voltage from 11,000 to 480 volts for the 440-volt motors. One three-phase motor-generator set is used in the substation with synchronous three-phase, 440-volt motors; 440-volt induction motors are used in tipples for conveyers and shaking screens and also for driving the 12-foot Sirocco fans used at the mines.

The camps are built in the most up-to-date manner. At the camp near the head of the creek about 3 miles west of Stone, are mines Nos. 6, 7, and 8. The water supply for the people there comes from a 10-inch well, 104 feet deep, near the creek. The water is pumped by a Weinman pump to a 40,000-gallon tank high on the hill, 170 feet above the Norfolk & Western tracks. The power for the pump is supplied from an attached General Electric induction motor.

The commissaries at the various camps are models in every particular. They are 60 ft. × 100 ft., and in two stories. They contain everything essential to a small department store in addition to a soda fountain and a pay-roll department. The cashier and store manager's offices are on a balcony or mezzanine. They are well lighted with 30 windows, and equipped with one hundred 30-candlepower Mazda lamps on each floor. Both floors are of hardwood. The basement underneath the whole building has a cement floor with a drain in the center.

Electric Mine Gas Detectors

Different Devices that Have Been Used or Suggested for Testing for Gas with an Electric Lamp

By Sydney F. Walker*

THE ordinary oil-burning safety lamp, performs a double office in coal mines. It furnishes light, and it denotes the presence of firedamp. Although the portable electric miner's lamp will not detect methane, it is safer than the ordinary gauze safety lamp; it is not so easily extinguished; and it furnishes considerably more light. The fact that the electric lamp will not detect gas is a disadvantage; nevertheless that has not prevented its adoption. In British mines some years back, portable electric lamps were very common, although not as strong nor as light as the Hirsch and Hubbell lamps; but at Murton colliery, Durham, England, some 2,000 Sussmann portable electric lamps have been in use for about 15 years. Since the series of explosions that have occurred in coal mines in the United Kingdom within the last 5 or 6 years, several of which have been suspected to be caused by the old form of safety lamp, there has been a strong tendency toward the use of electric lamps. The difficulty of the detection of gas is met by the provision of a certain number of safety lamps, by which gas can be detected. Firemen carry an electric lamp, and an oil-burning lamp for testing.

The essential feature which provides the safety of the electric lamp, the enclosure of the heated filament within a globe from which the air has been exhausted, the globe being protected by a stout glass similar to those used in the oil-burning safety lamps, precludes the filament itself being used in any way as an indicator of gas. In the electric lamps which have passed the Home Office, and which were awarded prizes in a competition which took place 2 years ago, every effort is made to cut off the current from the filament in case of any accident happening to the lamp. In the best of the lamps, the incandescent globe itself is placed between two springs, one of which makes connection with the battery; and anything which would cause a breakage of the lamp globe, immediately severs the connection, long before the gas could find its way to the filament.

Anything, therefore, which indicates gas, must be external to the lamp globe; and several attempts have been made to work out something of the kind. Up to the present there is no satisfactory electric gas detector upon the market. Inventors, so far, have worked along two lines. One inventor produced a gas detector that could be used by firemen, in which the difference in the rate of the diffusion of methane and ordinary atmospheric air, through a porous diaphragm, was made to operate an electric contact, closing an electric circuit, and lighting a small lamp that was colored red. As far as the writer is aware, this apparatus never went beyond the testing stage; but with the enormous developments that have taken place in connection with electric lamps it is well worth any inventor's

*Bloomfield, Crescent, England.

while to take up the subject on those lines. Another apparatus designed upon something of the same lines, but smaller and more portable, is arranged to be either carried in the pocket, or attached to a lamp. A U tube in which is a mercury column, indicates the percentage of gas, and the instrument, it is stated, can be employed to detect CH_4 or CO_2.

Turquand's apparatus for testing for gas in mines consists of the U tube shown in Fig. 1, the ends of which pass into slots in a metal block. The ends of the U tube are open, but the slots are closed by porous stoppers *a*, thus leaving a space *b* between each end of the U tube, and each porous stopper. In one space a palladium wire *c* is fixed, through which a current can be passed, either from the battery attached to the lamp, or from an independent battery. In the other space an absorbent has to be placed, so as to discriminate between CH_4 and CO_2. The U tube has a very fine bore, and in it is what the inventor terms a thread of mercury. Normally the mercury will be at the same level in the two legs. When a gas having catalytic value, that will act upon the hot palladium wire in the well-known manner, passes into the catalytic space, heat is liberated, and the thread of mercury is pushed down one leg and up the other. The U tubes are graduated, presumably in units, showing the percentage of gas. Fig. 2 shows the connections for supplying current, when the apparatus is in use.

Most all the other methods that have been employed depended upon the contact action between firedamp and a platinum wire; that is, when a combustible gas is brought in contact with a platinum wire and causes it to glow. The earliest apparatus, that of Professor Diveing, employed two platinum spirals, glowing equally; one in atmospheric air, and the other in the gaseous atmosphere to be tested. The percentage of gas was found by comparing the light given by the two spirals on a photometer scale. It was used some in English mines, but only by managers and others who possessed the necessary skill and patience. Sir Joseph Swan, soon after his incan-

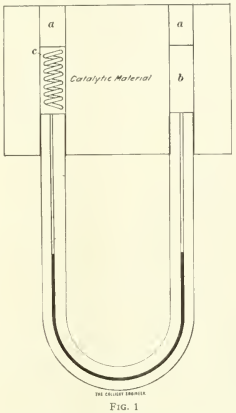


Fig. 1

descent lamp was perfected, introduced an attachment in which a column of mercury, which expanded under the heat liberated by the catalysis of the platinum wire, showed the percentage of gas upon a graduated scale.

Some 14 years ago, when the Sussmann portable electric lamp was introduced into the Murton, and one or two other collieries in Durham, an attempt was made to attach an indicator to the lamp. This was constructed along the same lines as Sir

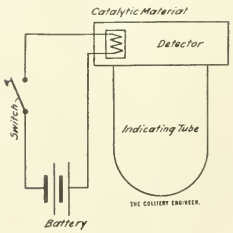


Fig. 2

Joseph Swan's; but the mercury bulb was covered with spongy platinum, and the action of the carburetted hydrogen gas upon the spongy mass caused a rise of temperature, which was recorded by a column of mercury moving over a graduated scale. The Sussmann lamp unfortunately was not successful commercially, though a very large number were employed on the Continent and in the United Kingdom.

Messrs. J. H. Holmes & Co., electrical engineers, of Newcastle, brought out a gas detector about 4 years ago that was intended to be fixed at different places in the mine, and to ring a bell in the overman's cabin, or on the surface, when gas appeared in certain prearranged quantities in the neighborhood of the apparatus. In this apparatus also, a column of mercury moving over a graduated scale, closed an electric contact; the bulb of the thermometer, as it was practically, being enclosed in spongy platinum. About three years ago, the problem was taken up by Mr. George Ralph, and the writer on behalf of Sir William Garforth. In Mr. Ralph's apparatus, a simple arrangement known as the differential galvanometer was employed. The galvanometer is an apparatus in which a current passing in a coil of wire surrounding a magnetic needle, causes a deflection of the needle, bearing a certain relation to the current. In the differential galvanometer there are two such coils acting in opposite directions upon the needle. Under ordinary conditions the needle is stationary; but if the current passing in one coil is greater than that in the other, the needle deflects. The current in one coil may be lessened by an increase in the electrical resistance of the circuit in which that coil is included; and this was the method adopted by Mr. Ralph. One of the coils of the differential galvanometer included in this circuit a platinum wire which was arranged to be exposed to the gas, protected by the usual gauze. When gas was present, catalytic action took place in the platinum wire, the resistance of the wire increased in a certain ratio to the amount of gas present, and the needle deflected. Variations of Mr.

Ralph's method included an apparatus for extinguishing the light given by the lamp; for putting a buzzer in action, and other arrangements. Unfortunately, all the experiments mentioned with the exception of those of Professor Liveing, and Sir Joseph Swan, were made with ordinary illuminating gas It was supposed by all those who were working at the problem, that town gas and mine gas were the same. In the United Kingdom, however, town gas contains about 40 per cent. of hydrogen, and only about 35 per cent. of methane; while mine gas consists almost entirely of methane. Hydrogen gas has a very much more energetic catalytic action upon a glowing platinum wire or spongy platinum, than methane; and it was found that the apparatus that gave excellent results with town gas, showing a fraction of 1 per cent. gas, gave absolutely no indications when taken into a colliery and tested in positions where it was known that methane was present.

The apparatus constructed for Sir William Garforth, was on totally different lines. Mr. Garforth had invented an apparatus for testing for gas with the ordinary safety lamp, in which a rubber bulb having a strong metal nozzle, was used. In the base of the oil-burning safety lamp was a tube, and a self-closing valve. When testing for gas, the bulb was placed in one of the cavities in the roof where gas was suspected, squeezed in the usual way, a bulb full of the atmosphere taken, a finger placed over the nozzle, the lamp taken to a safe position, the nozzle pushed through the base of the lamp, opening the valve in the process, and the gas in the bulb was squirted over the flame of the lamp. It will be seen that this method enabled tests of gas to be taken, easily and quickly, under conditions where it was almost impossible by the ordinary method, of nearly extinguishing the light, and pushing the lamp up into a cavity in the roof.

In the apparatus there were one or more small glass tubes, fixed inside of the usual protecting glass tube of the portable electric lamp. Each of the small glass tubes held a platinum wire of a gauge varying with the quantity of gas that was suspected. At the entrance to each tube was a self-closing valve that was pushed open by the nozzle of the rubber ball described above. It switched on the current to the platinum wire, and it opened the way for the gas to pass to the wire. In using the apparatus, the nozzle of the bulb was first pushed into the aperture, opening the valve, and time was given to allow the platinum wire to come to its proper temperature. The gas was then squeezed from the bulb over the wire. The little test tubes were arranged to be easily and quickly replaced; and the platinum wire was protected by gauze, in a similar manner, though on a small scale, to that in which the ordinary oil-burning safety lamp is protected.

The writer, with his client's full knowledge, worked with ordinary town illuminating gas, and with that, he produced detector tubes of sufficient sensitiveness to show the presence of .5-per-cent. gas. It was his intention to have gone on from that point, with pure methane; and he proposed to have used the metal palladium, which is more sensitive than platinum; and the measurements which he made upon an experimental tube in which a palladium wire was employed, showed that there was every probability of obtaining as great success with palladium and methane, as he had obtained with platinum and ordinary town gas, but his client would not go on. In the apparatus worked out for Sir William Garforth, it was arranged to carry one, two, or three tubes in any lamp, and there was a range of tubes, with corresponding platinum wires, all of the same length, but of varying section, so that tests from .5 per cent. up to 5 per cent. could be obtained. The method to be adopted was, the lamp man would carry tubes in his pocket and would make tests downwards. He would put in the coarser tube first, then tubes with finer wires, and so on.

Mr. George Ralph is said to be experimenting on the work, and another inventor is employing palladium. There seems to be no reason why something on the lines of what has been described above, using palladium, should not give a successful gas detector.

Kentucky Mining Institute and First-Aid Contest

The third annual meeting of the Kentucky Mining Institute will be held in Lexington, Ky., May 8 and 9, and the second State Wide First-Aid Contest will be held on the afternoon of the first day. All persons interested in mining and the mineral development of the state are cordially invited to attend this meeting.

This will be the greatest gathering of mining people the state has ever known.

The Lexington Commercial Club is working enthusiastically for the success of the meeting, and among other things they have addressed letters to manufacturers and dealers in mine equipment, machinery and supplies, asking them to join in an exhibit at the mining show. Efforts are also being made to secure the Federal explosion gallery to demonstrate the explosibility of coal dust, but this latter feature has not been definitely settled.

The Federal Bureau of Mines has been asked to take charge of the events on the field in connection with the first-aid contest.

There will undoubtedly be a great gathering at Lexington on this occasion, and hotel reservations should not be overlooked.

The secretary, T. J. Barr, Lexington, Ky., asks to be advised as soon as possible as to the number of teams that are expected to be entered in the contest, and the probable number of persons from each company who will attend the meeting.

Ravenswood Explosion

And the Coal-Dust Question—The Charge Limit for Safety Explosives—Use of Incombustible Dust and Other Precautions

*By Samuel Dean**

THE advocates of incombustible dust, for preventing or stopping explosions of coal dust, are increasing in number. But it is doubtful whether the magnitude of the coal-dust danger is yet realized as fully as it ought to be.

To prevent coal-dust explosions in mines where old wooden end-gate cars are in use it is necessary, not only to apply incombustible dust, but also to keep a staff of men constantly employed cleaning roads.

The questions now occur: Does the selling price of coal permit of the cost of constant, adequate road cleaning?

Can the operators, speaking generally for the whole of the United States, afford to scrap the old wooden cars and cross-over dumps now in use, and install rotary dumps and dust-tight steel cars?

If the answers to both of these questions is in the negative, then, how are coal-dust explosions to be prevented?

I will not attempt to answer this last question, but if any of the readers of The Colliery Engineer can give original ideas toward a solution they will no doubt be well worth reading.

Methods of applying incombustible dust have been frequently described, and the future will doubtless see more mechanical appliances used for spreading the dust. At the mines with which the writer is connected there is now a machine in use which blows 2,000 pounds of dust per hour. This travels through the roadways in the same manner as the machine shown in Fig. 2, which was described in the December, 1912, issue of The Colliery Engineer.

A recent explosion at the Ravenswood mine, near Walsenburg, Colo., emphasized the fact that permissible explosives are not to be relied upon when the charge limit of 1½ pounds is exceeded.

Two men were working at the face of the ninth south entry, and contrary to the mine regulations, drilled a hole 7 feet 6 inches deep at *a*, Fig. 1, into the solid coal. Before the hole was charged, the driver states that he saw probably 12 sticks of Monobel lying near the face. If 12 sticks were inserted the hole would be nearly full of powder. It is possible that the driver did not see 12 sticks—he did not count them, but it is quite likely that there would be 8 or 9 sticks (each stick weighs half a pound). It is quite likely also that the men tamped the hole with coal drillings, and left more drillings in front of the hole. The shot blew out and started a dust explosion, and both men were later found dead in the back entry *e*, at the place marked with crosses. Both bodies were severely burned.

The flame traveled less than 200 feet along the main entry, the stopping *d* in the last outby cross-cut being blown toward the back entry.

The coal bed in this particular part of the mine is 2 feet 8 inches high, which makes it necessary to brush 1 foot of floor and 2 feet of roof for headroom in the entries, as shown in section Fig. 3.

In Fig. 1 the face *a* is but 12 feet

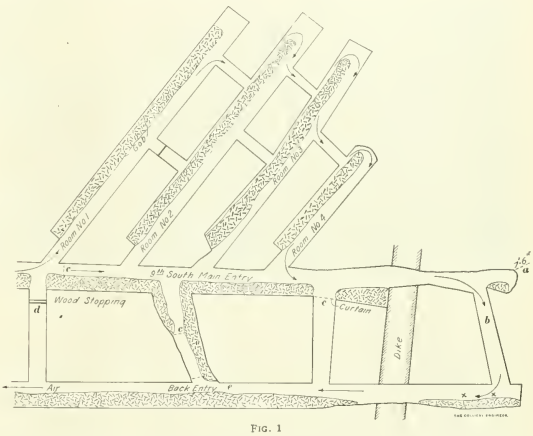


Fig. 1

away from the breakthrough *b*, through which 5,000 cubic feet of air a minute was passing. The four rooms shown were not working at the time of the explosion.

There were 92 men in the mine at the time the shot was fired, and it is claimed that shale dust lying in the entries prevented the spreading of the explosion.

The flame died out within 200 feet of the face, but the force went on and was felt in different parts of the mine, but did not do any further damage.

The dust was quite dry where the flame stopped and could be blown off the ledges away into the air-current.

There was no gas where the shot was fired and the two men who lost their lives were working with naked cap lamps.

*Delagua, Colo.

The Ravenwood mine is worked with open lights, and a shot firer is provided, whose duty is to fire shots only when all employes except himself are out of the mine. The instructions issued to shot firers by the Victor-American Fuel Co., are as follows:

1. Holes in coal must not be charged if they are drilled into the solid, or drilled deeper than the undermining.

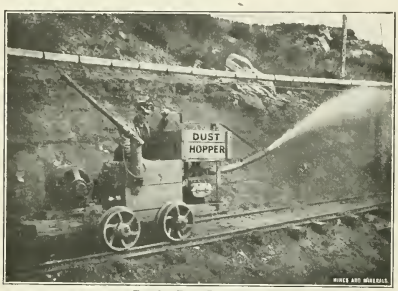


Fig. 2. Dust Distributor

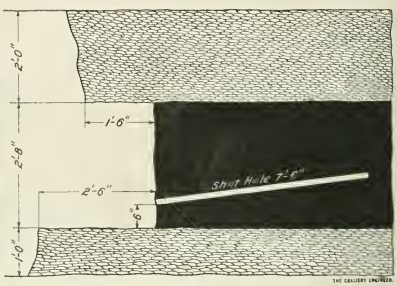


Fig. 3 Face of Ninth South Main Entry

2. Use only a wooden tamping bar with no metal parts.

3. See that all holes are thoroughly cleaned out and are free from coal dust before charging.

4. The charge limit is 1½ pounds of permissible powder per shot.

5. Do not fire any shots on main haulage roads unless you have written authority from the superintendent and unless the roof, floor and sides are drenched with water, or covered with adobe dust, or stone dust; and are free from coal dust for a distance of 100 feet, on each side of the shot.

6. Avoid shooting through a narrow web of coal into an adjoining place.

7. Tamp all holes firmly to the mouth with damp adobe.

8. Fence off every place in which there is a missed shot.

9. Do not smoke when handling explosives or detonators, and do not handle them near an open light.

10. Do not try to force a primer into a hole of insufficient size.

11. Use great care in carrying and handling blasting caps.

12. Examine, during your inspections after firing, for gas or fire, using a locked safety lamp. You are warned that powder smoke may contain dangerous gases.

13. Do not charge or fire any holes in a place where you find an explosive mixture of gas.

14. Missed shots must not be drilled out, but a new hole drilled and fired; the new hole to be at least 18 inches away from the missed hole, and pointed in a direction from it. After relieving holes are fired, the shot firer is instructed to endeavor to recover the unexploded caps and powder, or satisfy himself that the cap in the missed shot has been exploded from the concussion of the relieving shot; and report the result in either event after question relating to missed shots.

15. Do not commence firing before time appointed by the superintendent.

16. Fill in the "Daily Report" accurately and completely.

The miners are not supposed to have any blasting caps in their possession, or to fire any shots themselves, and the shot firer fills in a daily report as follows:

Ravenswood Mine,.....191
SHOT FIRER'S DAILY REPORT
District of Mine.....
Time first shot fired?.....
Number shots examined?.....
Number tamped? .....
Number fired? .....
Number of shots condemned, reason why, and where located? .....
Did you fire any shots on Main Haulage roads back from the face? .....
Number of missed shots, where located? .....
Number of blown out shots, where located, and cause of blow out? .....
Did you use a wooden tamping bar for all charges? .....
Did you find any one in the mine during the time you were firing shots? .....
Did you find any miners with detonators in their possession? .....
Did you examine all the places again, with the aid of a safety lamp, after you had fired the shots, and leave your initials in chalk on the face where the coal had been shot down?....
Did you fence off all missed shots?.....
Is your safety lamp clean, and in good condition? .....
Did you find any gas in the working places?..
State the correct time you left the entrance to the mine? .....
State here any further remarks you wish to make. .....
.....Shot Firer

It is customary to place the blame, for the high fatality rate in mines, upon the operator, but this accident shows what the miner can do when he is so disposed and wishes to take short cuts. One does not wish to refer to the dead unnecessarily or harshly, but the miner can not only cause his own death, but can endanger the life of every one in the mine. Men exist, of course, who will say that such miners are not "practical" or are inexperienced. But the miner who sufficiently understands the game to know that a deep, cracking shot, such as was used in this case, is likely to make it easier for him to put in his shearing, has perhaps had too much experience.

The shale dust in this mine is formed from the top and bottom brushing, much of which is gobbed along the sides of the rooms and entries. A large quantity of it gets crushed underfoot and mixed with the coal dust.

The following are analyses of the dust gathered from near the face of the ninth south entry after the explosion:

	No. 1	No. 2	No. 3
Moisture	6.51	6.19	2.95
Volatile matter	17.08	19.89	19.78
Fixed carbon	42.79	51.98	50.78
Ash	33.62	21.94	26.49
	100.00	100.00	100.00

Sample No. 1 was gathered at the face of the ninth south main entry, from around the hole that was shot.

Sample No. 2 was taken from the rib opposite cross-cut about 12 feet from face of main entry.

Sample No. 3 was gathered off the roadway from between the rails at different places, all from within 14 to 20 feet of face of main entry.

Had samples been gathered further outby along the entries, they would have shown a larger ash content. It is possible that there was 50 per cent. of shale in the dust mixture where the flame stopped.

Operating Induction Motors

Features of Installation and Care That Should Not Be Neglected—Ability of Motors to Stand Hard Usage

By C. A. Tupper*

THE increasing popularity of induction motors has been brought about by a number of conditions, among which are the following:

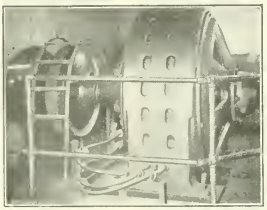
For most coal operations of large size, power is now generated as alternating current; hence it can be utilized without change in induction motors, either directly or through the intemediary of static transformers; whereas, in changing to direct current, a motor generator set or rotary converter needs to be kept in operation; with the expense and loss of power resulting therefrom, it is desirable to keep the size of such an auxiliary unit as small as possible.

Induction motors can be put on the line under load, even when a relatively high starting torque is required. They run approximately at constant speed, regardless of load, with only a slight drop between no load and full load; and if the load is suddenly thrown off, no racing occurs. The voltage in the rotating part is also so low that insulation breakdowns do not occur.

The motors can be installed in places not easily accessible, being readily adapted to distance control; and the absence of commutator in two- or three-phase machines eliminates any sparking, flashing or burning, thus reducing the hazard from fires or explosions of gas.

Finally, they are simple in construction, for the standard squirrel-cage motors have no rubbing surfaces or contacts except at the bearings; hence the cost of maintenance and attendance is low. With the exception of variation in speed, they have all the advantages and none of the defects of the shunt, or compound-wound, direct-current motors, with other merits peculiarly their own.

Their very simplicity and ruggedness of construction has in it an element of danger, in that it leads to abuses by the way of lack of proper attendance. The following observations are made with the object of calling attention to some of the features of installation and care that are often neglected.



Induction Motor Operating Fan, Gary, W. Va.

Induction motors, as ordinarily furnished by the makers, are assembled for floor or pedestal mounting. If it is desired to place them on the side walls or in reverse positions overhead, this should be specified, so as to have the end housings, oil cups, etc., arranged accordingly.

The location of a motor is usually determined by that of the machine or shaft it has to drive; but if there is any choice in the matter, a place where there is good ventilation and freedom from dust and moisture should be selected. The equipment of a motor usually includes slide rails, to permit of adjustment in position. When these are placed, it should be seen that the supporting surface is exactly even, so that the machine rests properly on them.

If a belt is used, this should run to the center of the pulley, so that the rotor will not be forced out of its central position. When properly lined up, the rotor ought, when running, to oscillate freely in its bearings. There is no need of running with a tight belt; the belt tension should be just sufficient to avoid belt slippage. Any greater tension puts an unnecessary strain on the belt and bearings.

In case the motor is geared, see that the distance between centers of the gears is correct, and that the pinion meshes properly with the gear. Slowly turn the rotor on its shaft and pass a thin piece of paper through the gears. The paper should show an even pressure across the full width of the tooth.

If the motor is small, use inclosed fuses in connection with the starter; or, with the large motors, use circuit-breakers. Fuses that are not out during starting should have current capacity of at least 2½ times that of the motor.

Trace all circuits, and be sure all connections are according to the diagram furnished by the manufacturer with the machine before attempting to start a motor for the first time, as a wrong connection may result in burning out a part of the starter.

While the smallest induction motors can be started safely by simply closing the line circuit, thus requiring no auxiliary apparatus, for those of, say, 5 horsepower and larger, full applied voltage would cause an undesirable rush of current, resulting in large fluctuations in line voltage, and perhaps interfering with the proper working of other apparatus connected to the supply mains.

At standstill, the rotor acts as the short-circuited secondary of a static transformer, and the large rush of current that results from full applied voltage may damage the windings. It is necessary, therefore, to provide means in the case of squirrel-cage induction motors—not the wound-rotor type—for applying a reduced voltage after the motor has come up to speed. This is done by means of a compensating starter.

Such starters are made in different ways and in different sizes to suit a wide range in voltage and output of the motors. The design and details of construction differ; but in all

*Cleveland, Ohio.

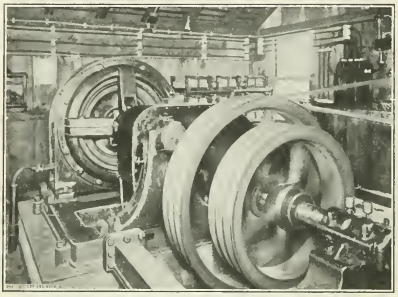
cases they comprise the essential elements of at least, two single-coil transformers, for reducing the voltage, and a switch for changing the connections between line, transformers, and motors.

At starting, the switch connects the transformers to the line, and the motor to the transformers, the motor being connected at a point that gives a voltage suited to the conditions under which it has to start. On the running position the motor is connected directly to the line, and the circuit through the transformers is broken; so that no current flows through them during the regular operation of the motor. The transformers are each provided with taps, and by adjusting the tapping-in point, the voltage at starting, can be varied.

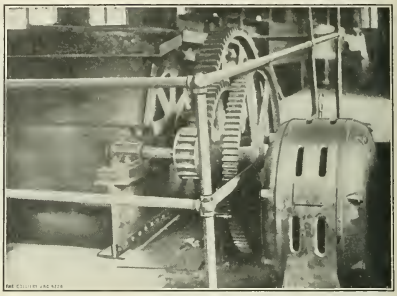
Starters are usually arranged to open the circuit in passing from starting to running, having only one starting point. They are designed so that it is impossible to move from "off" to running without passing through the starting position, or to introduce the starting connections in moving from running to "off."

The handles of most starters are turned in a clockwise direction to start and stop the motor, and can only be moved in the reverse direction to return, if desired, from starting to "off."

The practice of stopping and starting a motor by throwing the power off and on is an extremely bad one. It results in burned contacts and is sure to lead to trouble with the starter. When the handle has been placed in a starting position it should be allowed to rest there for a short time, and then moved quickly to the next starting position, or to running, as the case may be.



One Hundred Horsepower Induction Motor Operating Slush Dredger and Scraper Line, St. Nicholas Colliery



Twenty Horsepower Induction Motor Driving Picking Table, Gary, W. Va.

Motors are usually tested by the manufacturers for all conditions of load that can reasonably be expected to be imposed upon them, as well as for heavy temporary overloads. It is customary to run them at the factory long enough to make sure that the bearings are satisfactory. If the motor is properly set up there should be no trouble with the bearings, but in case they show signs of heating, the cause ought always to be looked for at once.

In setting up a motor, the oil wells should be carefully inspected to see that no dirt has gotten into them during shipment. If it is found that the oil wells have become dirty, they should be blown out, and if considerably clogged, the use of gasoline as a cleaner is advisable. After making sure that they are clean, fill them with a good grade of mineral oil, preferably dynamo oil that is easy flowing and readily carried up by the oil rings. The use of graphite or similar lubricants is not desirable, as it clogs the oil ducts and interferes with the operation of the oil rings. Sufficient oil must be kept in the bearings at all times so that the rings will dip well below its surface. When the motor is first started, examine the rings to see that they revolve and carry up oil. Examine the oil occasionally, and if it shows any signs of dirt or grit, draw it off and replace with a fresh supply.

Some of the most common causes of hot bearings are, poor grades of oil; grit and dust in the oil well and bearings; foreign particles in the oil grooves that stop the circulation of oil; oil well not full; too tight or too heavy a belt; too much end thrust on the rotor; sprung shaft; Babbitt worn down or out. The bearing surfaces in most motors are of ample area, and experience has shown that practically all trouble is due to faults either in the setting up of the machine, or in operation, rather than in design or manufacture.

The bearings of induction motors should be given special attention and, if possible, inspected daily. The air gap between stator and rotor is necessarily small in motors of this class, and an undue amount of wear in the bearings may allow the rotor to rub on the stator. The air gap should be examined frequently, and, if there is danger of rubbing, the bearings should be replaced by new ones. On some of the larger induction motors the bearings are

made adjustable, so that the rotor can be shifted to secure a uniform air gap, but for the smaller sizes it has ordinarily been found more satisfactory to renew the linings than to go to the expense and complication of adjustable bearings.

While these motors will run with a minimum of attention, they should not on that account be neglected; neither should dust and grit be allowed to accumulate around the windings or bearings. The motor should be wiped thoroughly at regular intervals and the dust blown out from all the parts. If the motor has to operate in a damp place, it is a good plan to give the projecting parts of the stator coils a coat of waterproof insulating varnish to help protect them.

All motors show a rise in temperature after running for some time. Should a motor feel warm to the touch there is no occasion for alarm, unless the degree of heat gets beyond the usual guarantee of 40° centigrade or 104° Fahrenheit. But if any excessive temperature rise is noticed the cause should be looked for at once. It may be found that the motor is overloaded or that the voltage applied to the motor terminals is considerably higher than the normal.

If an induction motor is loaded beyond a certain point it will stop. If this is apparently not due to overloading, which is the first thing to inquire into, and an examination of the bearings and air gap does not show rubbing between the stator and rotor, the explanation may be found in an abnormally low voltage in the supply circuit. The torque exerted by an induction motor decreases as the square of the applied voltage; hence a comparatively small drop in voltage produces a large decrease in torque; and, if the motor happens to be carrying a heavy load at the time the voltage falls off, it will come to a standstill. To obtain the best service from an induction motor it is important that full voltage be maintained. It is much better to have the voltage on the high side than on the low, although it should not be allowed to become high enough to cause excessive heating.

The extent to which induction motors are damage-proof, even from long submergence in water, was shown by the record of one installed at a mine, where there was a 35-

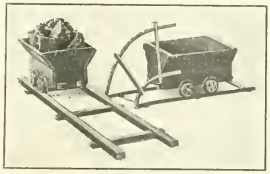


Fig. 1

horsepower motor driving a centrifugal pump, which became completely submerged during a flood, in consequence of the backing up of the adjacent river. In this condition it remained approximately 3 months. After the machine was taken from the water and the mud incasing it had been removed, it was merely covered with a tarpaulin and allowed to remain for some months in the open. Nothing further in the way of service was expected from the machine until it had been rebuilt. Later, however, there was emergency need of another motor, and the mechanical foreman at the

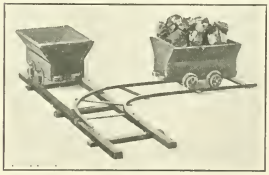


Fig. 2

mine tested this machine. To his surprise he found the motor all right, and it was at once placed in service. This occurred in the fall. The motor continued running until spring, when it was again submerged and again put in service after the flood, being still in operation.

Portable Branch Track

By Joseph Kober

After a machine cut is made and the coal broken down, the car loaders must shovel coal once or twice over to get it to the track or straight-rib side of the room. In doing this they practically perform the work of loading the same coal two or three times.

Not believing in this method of car loading, because it makes more slack and wastes energy, the writer conceived the plan of a portable branch track, which is intended to save time in loading and save work in placing the car to be loaded.

The usual method adopted is to haul the loaded car from the coal face with a mule and then deliver the empty car with a mule, or else the car loaders push the empty car from the room neck to the face, which is not only hard work, but also takes time.

In addition to this, if the mule driver is not on hand, or the loaders have lost their turn for some reason, there is a much longer waste of time. As shown in Fig. 1, the portable track is sectional, easily taken apart and is practically a parting, which can be moved forward after each machine cut. The curve end of the portable track is raised or lowered to conform with conditions.

In Fig. 1 the loaded car is at the face ready for the mule to haul out of the room. When the driver comes for the loaded car his mule pulls in an empty car on to the branch track where it is loaded. This track, which is parallel to the face, is so close that the car can be readily loaded without reshoveling coal. On the next trip the driver pulls the empty car up to the face on the straight track as shown in Fig. 2, after which the portable curve of the branch track is lowered and the loaded car pulled out. This arrangement should appeal to every mine manager using coal cutters in rooms as well as to managers whose mines are worked by pick.

The Personal Equation

In Engineering—Differences in Results Obtained from Two Methods of Calculating Excavation and Pillar Areas by Different Engineers

*By William Griffith**

THE personal equation enters very seriously into engineering practice. You know we can none of us do anything exactly. We are creatures of error. We cannot even write our names twice alike. Everything we do is subject, more or less, to unconscious error, and we cannot help it. And these errors, small in many ways and large in other ways, enter into everything we do.

In engineering practice these errors amount to considerable. And it is for this reason that, in court

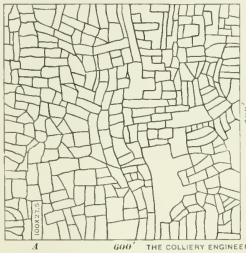


FIG. 1

questions, the work done upon mine surveys and mine maps at times when there was no legal question involved and all parties were entirely unbiased, is considered more accurate, or fairer as between the different litigants, than the same work done by biased corps for the purpose of proving one side or the other of a contention. The condition of our minds affects more or less the exactness of our manipulations and our work.

It occurred to us that it would be very interesting to take up this line of thought and investigate to find out, if possible, just how large the personal error is in certain lines of engineering work and in what way these personal errors balance or combine—if they do—to increase or decrease the total error, etc. So we have taken for this evening's consideration the subject of the estimation of the area of pillars on a mine map, with a planimeter or otherwise. The planimeter is an exact instrument—supposed to be; but the trouble is that these instruments cannot be any more exact than the man who manipulates them. One man will make more errors than others, depending upon the degree of care and skill. In using these instruments, if one does it frequently, he is liable to get in the habit of following certain methods over and over again, and thereby perhaps repeating the same error. If the instrument is just a little out of adjustment there will also be errors. So there is ample opportunity for error in using a planimeter.

In our own practice we have had only slight occasion to estimate such errors with accuracy, and have usually used a method known as "grouping the pillars." We have thought that perhaps this method may be more accurate than by the planimeter, because it is so very simple (although perhaps requiring more time). It only requires the placing of a tracing cloth on a mine map, after first drawing on the tracing cloth three sides of a rectangle. Then with a lead pencil, trace off, within the rectangle, a pillar; move the tracing and trace another pillar so that it fits close against the first one, and in that way transfer all the pillars from the map to the inside of the rectangle. They fit like the scales of a fish, and it is surprising to see how perfectly you can fit the traced pillars together and how rapidly it may be done, with some practice.

We will make this investigation along both of these lines and see whether one might not be used as a check on the other. It first became necessary to fix upon some sort of standard for comparison, from which our own personal error should be, as far as possible, eliminated. We laid out on paper a rectangle exactly 6 inches square, on the scale of 100 feet to the inch, 600 feet square (Fig. 1), and then divided that into small, irregular patches or fish scales about the size of mine pillars, so that the total area of all of the little parcels or "fish scales" on that square would amount to 360,000 square feet. But fearing that perhaps 360,000 was such a comfortable round number that some of the assistants might suspect it, we subtracted one of the pillars, i. e., left out pillar *A*, having an area of 2,750 square feet, so that the area of the pillars used was 357,250 square feet. We then arranged all

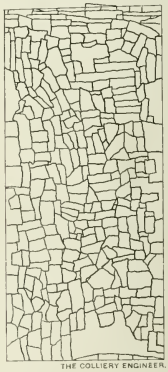


FIG. 2

those irregular parcels or "fish scales" or pillars in the form of a mine map. Fig. 3 is built up of those small fish-scale pillars that are in that square. Consequently the area of all of the mine pillars on this map is the same as the area of the parcels in the square, minus the one pillar which was not used, making allowance, of course, for our personal error, whatever it might be.

*Address before the Engineers' Society of Northeastern Pennsylvania, March 19, 1914, at the Engineers' Club, Scranton, Pa.

Then the question was to ascertain our own personal error. It occurred to us that we would probably make the same kind of an error if we grouped the pillars back into a rectangle again. Therefore, on another piece of vellum cloth, we grouped them all back into a rectangle and scaled the area of the rectangular group of pillars (Fig. 2). Then subtracting this result from the 357,250 square feet, gave our own personal error in the two processes of analysis and synthesis. Dividing this by two would give the personal error of one operation, on the assumption that the error would be approximately the same in both operations.

After doing that we had several blueprints made of the imaginary mine map, and submitted one to each of several engineers' offices of the city, who kindly agreed to have the area of the pillars taken off by planimeter and by this grouping method. Some of them had never used the latter, and others used it but seldom, having depended on the planimeter almost exclusively. Therefore the manipulators who assisted me in all the offices were not familiar with the grouping method, being practically novices at it. In this comparison this fact should be kept in mind, remembering that smaller errors would naturally follow more familiarity with and practice of the "grouping method."

We are indebted to the following engineering offices for assistance in this investigation: Stevenson & Knight; Delaware, Lackawanna & Western; Delaware & Hudson; Lackawanna Coal Co., Ltd.; Scranton Coal Co.; Connell Coal Co., and the Pennsylvania Coal Co. Engineers in all of these offices kindly estimated the pillar areas from the blueprints by both the grouping method and with the planimeter, returning the results of their work, which we have compiled in the tables here shown.

First, let us look at the results under the "Grouping" method. The area of the pillars or fish scales of that first rectangle was 357,250 square feet, and the total error in tracing them off, forming them into the mine map and then grouping them back again into a rectangle, was 8,250 square feet; that is, the two rectangles differed that much in area; consequently one-half of the error, or 4,125 would be the personal error in each operation, assuming that the errors were equal. Thus the area of the pillars on the tracing would be 357,250, minus 4,125 square feet, because the error was a minus error. The area of the mine pillars on the tracing of the mine map would therefore be 353,125 square feet. To get at the area of the pillars on the blueprints of the mine map, we subtracted from this area the shrinkage of the print, as shown in Tabulation *A*. One print would shrink more than another; therefore the pillar areas on the several blueprints were not the same.

In Tabulation *A* the different manipulators are designated by the numbers in first column. The second column shows the standard area in square feet for the pillars on tracing of the mine map as above explained. Column 3 contains per cent. of shrinkage of each blueprint. Column 4, the standard area for pillars on each blueprint. Column 5, the results returned from the several engineers' offices. Column 6 gives time required in each case, etc.

It will be noted by a study of this Table *A*, that the time required is no criterion by which to judge the accuracy of the work, for some of the speedy manipulators made small errors. The 8¼-hour man, No. 7, seems to be an exception to this rule, however. When the engineer returned his results, he apologized for his assistant, who used the grouping method, saying he was a new boy in the office—a novice—and that he had himself obtained the results with the planimeter, which explained the difference between the two. And yet, notice the small error. Only 113 square feet of difference between his work and the actual area of the pillars. And the 48-minute man had an error of minus 561 square feet, or sixteen-hundredths of 1 per cent.

As to the planimeter work shown

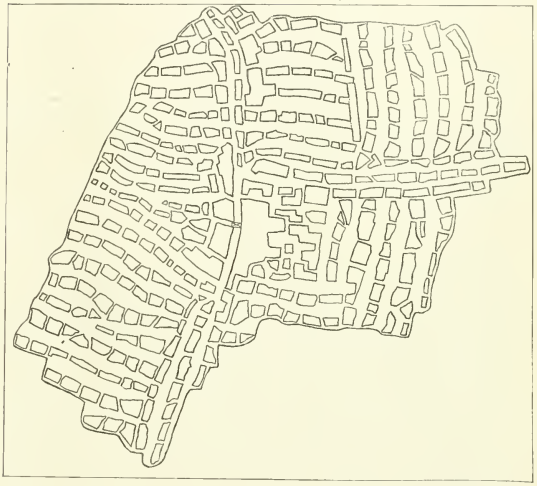


Fig. 3

by Table *B*, we have the same blueprint area in each case. By comparison, we notice, however, that the time required with the planimeter is much less than by the grouping method (when the latter is manipulated by novices), but the errors with planimeter (operated by experts) average twice as great. It would be interesting to know how the results of the two methods would compare if the former one were also operated by experts.

The tables show the average error by the grouping method is .58 per cent., and by the planimeter 1.225 per cent. Or, if we exclude in each case the tests showing excessive errors, i. e., No. 6, Table *A*, and Nos. 5 and 6, Table *B*, the average error by grouping is .117 per cent., and by the planimeter, .589 per cent.

Some of these manipulators not only returned the area of the pillars, but also the area of the mined-over space. And it is interesting to compare these results and then compare the errors, and note the result of the combination of errors as affecting the area of actual excavation; for instance, if we were going to estimate the tonnage of coal removed from the land.

It again became necessary to accurately obtain the mined area from the blueprints as a standard for comparison, and as the ordinary methods of measuring areas from maps were not considered sufficiently exact, we determined the desired area in the following manner: We drew a rectangle 13 inches long by 12 inches wide, on two of the blueprints which had the same amount of shrinkage. Then we cut the two rectangles out of the paper and had them weighed on a very delicate balance. We also carefully cut out the two maps and had them weighed. The rectangles from the two maps weighed 18.29925 grams and the two maps weighed 10.1535 grams. By a simple calculation we determined the mined-over area of the blueprint map to be 865,557 square feet. Of course, we corrected this area for the other two sheets, according to the difference in the shrinkage. Table *C* shows the results, compared with the standard, and the per cent. of error in each case. Some are plus and others minus.

Table *D* is intended to show how the various plus or minus errors made in estimating both the pillar area and the mined-over area will combine to affect the ultimate result of the computation of tonnage.

Thus we find from Tables *C* and *B* that No. 2 made the total mined-over space 4,182 square feet too large, and he made the pillar area 4,661 square feet too small; consequently, his excavation would be 8,843 square feet too large. His estimate of tonnage mined would therefore be 1.7 too much; while No. 8 would estimate the excavation .67 per cent. too small; and the difference between the greatest plus error and the greatest minus error would amount to 2.4 per cent. of the excavation.

The conclusion brought out clearly by the investigation is that even with refined instruments of precision, the unavoidable personal errors unconsciously made in the most careful engineering practice are sufficient at times to cause the results of the work to be much less accurate than those obtained through much cruder methods requiring less manipulation.

(Then followed the discussion of the subject by Mr. Griffith and the members of the Club.)

Mr. Griffith stated that he found by tests in his own practice that it made a difference whether he used a hard or soft pencil in taking areas by the "grouping method"; that is, when he used a No. 4 pencil with fine lines, his results were too small. No. 2 pencil making thicker lines produced results too large, while with No. 3 pencil, medium line, his results were very close to the actual areas.

TABLE *A*. RESULTS BY GROUPING

	Pillars on Tracing	Shrinkage Per Cent.	Pillar Area Blueprint	Pillar Area Grouping	Time Hrs.	Time Min.	Difference	Per Cent. Difference	Remarks
1	353,125			353,700	1	54	+ 575	+ .163	Average of 2 trials
2	353,125	1.25	348,711	348,150	48		− 561	− .160	Average of 2 trials
3	353,125	1.40	348,181	346,000	3	—	− 2,181	− .630	
4	353,125	1.40	348,181	345,000	3	45	− 3,181	− .910	
5	353,125	1.20	348,887	350,000	3	30	+ 1,113	+ .320	
6	353,125	1.15	349,064	337,000	2	—	−12,064	−3.400	
7	353,125	1.20	348,887	349,000	8	15	+ 113	+ .032	
8	353,125	1.40	348,181	348,000	5	—	− 181	− .052	
	Average	.	.	.....	3	15	− 2,044	− .580	

TABLE *B*. PLANIMETER RESULTS

	Pillar Area by Grouping	Pillar Area by Planimeter	Time Hrs.	Time Min.	Difference	Per Cent. of Difference	Remarks
1							
2	348,711	344,050	24		− 4,661	−1.340	Average of 2 trials
3	348,181	346,302	1	00	− 1,879	− .540	Average of 2 trials
4	348,181	345,256		32.5	− 2,925	− .840	Average of 2 trials
5	348,887	336,500		45	−12,387	−3.550	Each pillar separately, 339,700 Difference—9,187; time, 5 hr.
6	349,064	341,800	1	30	− 7,264	−2.080	
7	348,887	337,875		37	− 1,012	− .290	Average of 2 trials
8	348,181	348,400		55	+ 219	+ .063	
	Average			52	− 4,272	−1.225	
	Average with Nos. 5 and 6 out.....				− 2,051	− .589	

TABLE *C*

	Area by Planimeter	Area by Balance	Difference	Per Cent. of Difference
2	871,000	866,872	+4,128	+.48
4	861,181	865,557	−4,376	−.58
5	863,200	867,112	−3,912	−.44
8	862,300	865,557	−3,257	−.38
	Average		−1,841	−.21

TABLE *D*

	Difference in Area Mined	Difference in Pillars	Difference in Excavation	Excavation*	Per Cent. Error
2	+4,128	− 4,661	+ 8,843	518,161	+1.70
4	−4,376	− 2,925	− 1,451	517,376	− .28
5	−3,912	−12,387	+ 8,475	518,225	+1.60
8	−3,257	+ 219	− 3,476	517,376	− .67
	Excavation Difference 2+8		12,319	517,784	2.40

*Found by deducting pillar area, column 2, Table *B*, rom area by balance in Table *C*.

The Employer's Duty

Improvement of Living Conditions at the Mines—Importance of Careful Supervision of Work with View of Increasing Employes Capacity

By M. C. Butler*

THE majority of workmen have the idea that how they spend their money or how they spend their time away from work is of no concern to the employer, and many employers have accepted their point of view.

But it is very much the employer's business when a workman spends his money foolishly, or acquires habits that undermine his health; for such a man cannot be contented no matter how much money he earns; besides, as he dissipates his health, his earning capacity is reduced.

He who spends his spare time in pursuits detrimental to his well being, must degenerate physically and mentally. If such men work by the day or month, their output is on the decrease. If they work on contract, their annual earnings will show a decrease, and this causes them to feel underpaid—the employer's fault and not theirs.

If wages are doubled and trebled, the workman is not going to be any better off financially, because the cost of living goes in the same direction, with the cost of living generally in the lead.

The employer should endeavor to encourage thrift and sobriety among his employes and thus set a personal example. The extravagance of a certain class of rich is largely responsible for the socialistic ideas that prevail among working people. The time is past when workmen have respect for shows of wealth—they now feel that they are paying for it, and should be doing such things themselves.

The living conditions at mines must continue to improve, not as a matter of show, but through sensible improvements. The isolated camp must be provided with schools with playgrounds, with a public hall suitable for dances, entertainments, moving-picture shows, and a night school. Mine workers should be provided with healthful recreation to prevent their engaging in undesirable pastimes, and to give them something to think about besides troubles.

The words "model camp" are pretty near a farce as it is mostly on the outside for show. It is not wise to go to the extreme of installing bathtubs in all houses, regardless of who is going to occupy them. Plain houses, well arranged and well built will suit any class of mine workers.

When you have a progressive tenant, put in the extra improvements as they are desired, and they will be appreciated. All of the foreign races will improve if they are properly encouraged, but it takes time.

Never give tenants anything for nothing. If the house needs papering, furnish the paper and have them do the work, or, let them do it all and allow them a month's rent; but go and see what kind of a job has been done before allowing the credit. Build the fence if they will fix up the yard.

Every camp should have a good change and bath house. If men work in wet and mud, they will seldom complain if they can have a good hot bath when through with their shift, and they know their shoes and clothing will be dry for next shift.

It gives a man self-respect to go home clean. He keeps in better health; looks better; keeps the house cleaner; and saves the housekeeper much unnecessary work: Further, it is degrading to have the men bathing in the kitchen, as they generally do.

If the company owns the store, the store manager must understand that it is his duty to please his customers, just as though he had the keenest kind of competition. Make the management of the store and the prices an inducement for the people to live in the camp, and not charge such prices as will cause talk about high prices.

The houses, hotel, store (and saloon, if there is one) should be considered as sociological matters and not pure business propositions, because profits should come mainly from the mine, and not from these sources.

Foremen should receive more money in wages than any of the men under them can earn. Few can keep up interest when men under them make more than they do. A proper salary will take away any temptation to show favoritism or vent spite.

The usual contention is that men working on contract or straight work do not need much supervision; but they do, and if they do not make good the employer will eventually pay for their failure.

Every man in the mine should be visited at least twice a day, once shortly after going on shift, so that just exactly the conditions under which he commences work may be known; and again just before going off shift, to see how he has performed that day's work.

In starting new men, an experienced man should direct them, to see that they get started properly. As work differs in each mine, this supervision will make more efficient workmen, prevent accidents, and give a steadier class of men.

Few employers realize that it is a very expensive proposition to have a constantly changing force. Even when men quit on account of their lack of experience, it does not have a good effect on other workmen with whom they come in contact.

Money spent in trying to improve the capacity of employes is well invested. They realize that the employer is at least interested in their welfare. If workmen are shown how to do more work in the same

*Paper read at local section meeting of A. I. M. E., at Seattle, February, 1914.

time and easier, the employer will save some increases in the wage schedule. The superintendent should not allow any man to be discharged or leave without first inquiring into the reason. This will cause the foreman to be sure that the man has had a fair deal, and the employes to feel that they are not liable to be fired by the foreman in a fit of ill temper.

If the employer upholds a foreman who is in the wrong, it causes the men to lose confidence in his sense of fairness, and this is the most valuable asset the management of any concern can possess. Mine workers are often not given credit for being as intelligent as they really are. If you raise the pay of an employe who is justly entitled to it, his fellow workmen will be glad of it, but if you raise the pay of a workman whom his coworkers do not recognize as a better man, you disorganize that crowd.

I am very much in favor of selling ground to employes—of course with certain restrictions; also selling them houses and land on the instalment plan. An employe who wants to remain where he is, can be considered generally a desirable one. In view of the company not being in the real estate business, merely providing accommodations for its employes, provision should be made to purchase the houses and ground at a previously fixed price, any time that it is desirable for the company to again own them.

Good men prefer to own their own houses, and this renting business is creating a transient class that seldom accumulates money or goods.

Usually, after a man has set timbers for a few months and sees how miners do their work, he quits and goes to some other mine and secures a job as a miner. The foreman cannot always tell how much experience the man has had.

It is largely on account of the inefficient men that demands are made for more pay, therefore, to make men more efficient in their work, is the employer's problem.

The timberman and laborer, after a proper time in the mine, should be placed with an experienced workman—not as an equal partner, but as an assistant or helper—the miner paying his wages, until he has had sufficient experience to work as a partner. This will encourage green men to go into the mine, and will insure safety and competent workmen, who will not continually change camps.

Mine owners have done little or nothing to develop good miners, and consequently the quality of this class of labor has deteriorated.

The whole problem of labor must be solved by the employer.

I am opposed to arbitration, because it only postpones trouble and never creates a good feeling between the employer and employed. It is like a horse trade. The employes ask for more than they expect to receive, the employer offers less than he knows they are entitled to, and they each try to get the better of the other, when a true spirit of justice should prevail.

Withholding things that employes are fairly entitled to, just to use as a concession at an arbitration, is not right. I firmly believe in immediately granting all things that the workmen in justice are entitled to, and just as firmly refusing things to which they are not entitled. This method of procedure will create a "square deal" feeling between all concerned.

All concessions allowed by arbitration are considered by employes as being forced from the company, and makes them feel that they have to force the granting of everything they should have.

I am in favor of unionism—that is, collective bargaining. It is absurd for an employer to say that he will deal only with his men individually. They cannot cope with him as individuals. They have no bank accounts to keep them until they find work agreeable to them, but must accept wages and employment offered.

Every employer should be willing to meet his employes collectively on the wage problem. If he is fair, and the employes feel that he is, he will have few labor troubles.

Considerable is being said lately about voluntary organizations. There is not much about the membership of unions that is voluntary, and the men know there is something fundamentally wrong with any union whose life depends upon an arbitrary deduction of its dues from the pay roll. No man should be allowed at the head of any union who is not a citizen of the United States.

Unionism has become a "Big Business," and should be compelled to incorporate and be treated the same as any other business enterprise. This proposition is going to become more overbearing than the employers were before the advent of the unions, and it must be met with strong opposition to keep it within reasonable bounds, for the good of the laboring men as well as the employers.

Regarding the membership of United Mine Workers of America:

Organized in 1890.

Membership, November 30, 1913, 383,520 (this figure materially augmented during 1913 by capitulation of West Virginia mine owners).

Government reports average employes in and around mines in 1912, 722,662.

Barely half the men working around mines are union men.

Receipts National organization, 1913, $2,159,031.

Expenditures, 1913, $2,102,261.

The statement of the organizers that the "miners in Colorado demanded the union," need something more than words to make them true; for instance, take statistics relative to this union given in the following:

December, 1912, there were in Colorado, 1,632 union men; June, 1913, 937 union men. September, 1913 (strike called), 2,070 union men; November, 1913, 3,898 (after the call of strike, when the men would naturally flock to the union on account of the promise of the

union to provide for them during the strike). There are about 14,000 men around the coal mines in Colorado, so it is plainly seen that a majority did not want the union at the time the strike was called, nor have they since wanted the union.

Nor can it be called a voluntary organization when one-seventh of the total number can cause so much trouble and inflict such terrible suffering and want on such a large number who do not want to take sides either way.

At the recent United Mine Workers of America biennial meeting, two resolutions were passed, which show clearly their line of action for the future.

Resolved, that we favor a shorter work day, and that the hours of labor be cut down until our surplus labor is fully employed.

Resolved, that we favor the enactment of a law prohibiting immigration from any and all foreign countries until our surplus labor is fully employed.

Illinois Mining Institute

At a meeting of the Executive Board of the Illinois Mining Institute, held at Peoria, April 1, at the Fey Hotel, it was arranged that the May meeting of the Institute would be held in Peoria, May 14, 15, and 16.

Every person interested in coal mining is invited to become a member of the Institute and be present at this meeting.

Information in connection with the work of the Illinois Mining Institute can be had by writing to Martin Bolt, secretary and treasurer, 1526 South College Street, Springfield, Ill.

Correction

In the description of the Austrian trial gallery on page 540 in the April number, there was an error in the dimensions shown on the plan of the gallery, Fig. 3. The over-all dimensions should have been 963.6 feet, and the dimension shown at the right should have been 565.1 feet instead of those shown.

The Cement Gun and Gunite

The cement gun is an invention that has been used some time, but as yet has not been applied to mining, probably because the company introducing the apparatus has not pushed it until it has accumulated sufficient data to guarantee its success. As it is now in use by the United States Government, and several railroads, besides has been investigated by Westinghouse, Church, Kerr & Co., independently of the manufacturers, it may be considered by the mining fraternity.

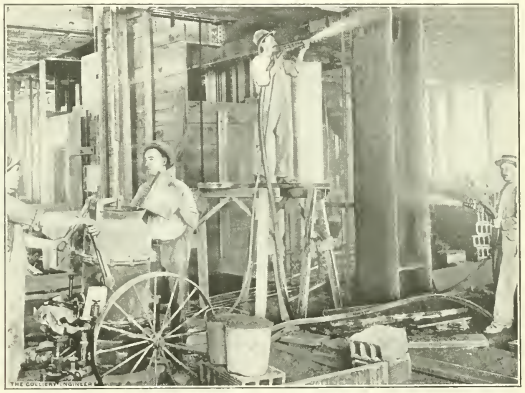


Fig. 1. Cement Gun Coating Columns

The apparatus is shown in Fig. 1, mounted on a truck. It has a hopper in which a mixture of cement and sand is placed, and this dry mixture is forced by compressed air through a hose having a specially constructed nozzle to which a hose supplying water is attached for hydrating the material. The material leaves the nozzle at a velocity corresponding to a pressure of 35 pounds per square inch. The combination of cement, sand, and water, necessary to produce a plastic material, takes place between the nozzle and the object to be coated, the chemical reaction commencing as soon as the water comes in contact with the cement and sand. The initial set of the cement mixture takes place therefore, at its final resting place and not on the mixing board as in hand mixtures. The cement gun uses only the necessary amount of water for hydration, and by reason of the materials being applied with considerable force, all surplus water and air are expelled and the mixture need not be disturbed after being placed.

According to Westinghouse, Church, Kerr & Co.'s experiments "the product of the cement gun was superior to hand-made products of the same kind. In tensile strength, gun work excelled hand work in every case by amounts ranging from 20 to 260 per cent.. In compressive strength, gunwork was even more marked, being from 20 to 720 per cent. better than hand work." The same firm reported the absorption of water to be less, the percentage of voids to be less, and the adhesion on an average to be 27 per cent. better than hand work.

"In compressive strength, gunwork was even more marked, being from 20 to 720 per cent. better than hand work." The same firm reported the absorption of water to be less, the percentage of voids to be less, and the adhesion on an average to be 27 per cent. better than hand work. The apparatus might be placed on

a truck and hauled to any part of the mine and worked, provided compressed air or electricity is in use at the mine. In case of air, the matter is simplified; in case of electricity, a portable air compressor electrically driven would be required. If one thinks about the different places inside and outside of mines where cement guns would be found serviceable, the list becomes long.

Taking the matter of employes' houses, no sheathing or clapboards are required. Builders' paper is nailed to the studding and over the paper is applied woven wire as reinforcing material. On to this backing of paper and around the woven-wire mesh, the cement mixture is applied, which forms a stucco superior to that hand made, and makes a neat, warm house that requires no painting.

It frequently happens that concrete mine portals and concrete arches and shaft bottoms crumble, owing to various causes, which would not have occurred had it been possible to have finished them with the cement gun. Resurfacing with the gun not only prevents further disintegration of massive concrete walls, but makes them stronger than they were originally.

The gun could be used to prevent concrete crumbling in retaining walls; for stopping leaky steam and air pipes; for repairing any contraction cracks in concrete breakers, tipples or slack bins; for stopping leaks in water tanks; for strengthening and preventing the rotting of tipple timbers or other buildings; for fireproofing roof, etc.

In Illinois the shafts must be lined with fireproof material, and this gun affords a quick way of accomplishing the matter, further it affords an excellent method of partitioning compartments in shafts. At the shaft bottom it should be used in surfacing arches, ditches, and steel timbering, particularly if there is any corrosion from moisture and gases, or from acid water.

The product of the cement gun which is called Gunite, adheres to cast iron or steel and thus forms a protective coating for pipes, steel columns, beams, or girders, and as its surface permeability is small in comparison with concrete and hand work, it should be impervious to water and prevent corrosion. It is not probable that it will prevent electrolytic corrosion; however, M. Force, chief chemist of the D., L. & W. Railway, has succeeded by the aid of some compound not yet disclosed, in preventing even electrolytic action taking place through cement to the steel members of a bridge or mine structure. Additional applications of the gun inside the mine could be found in making air-tight stoppings and crossovers; making the spaces between the walls and door frames air-tight; making inexpensive, light, and durable air stops in breakthroughs; making good brattices where it is necessary to split the air and keep it circulating in one direction for an unknown but not permanent period of time. It is also possible to make use of the gun in filling up cracks through which water drops on the road bed and causes it to mush up under the traffic, and force this water to fall only in the ditch where it belongs. It could be made use of in lining sumps, underground stables, pump houses, and engine houses. The gamut of the usefulness of this cement gun has not been run, and managers, engineers, and mine foremen can find other instances in their practice where it could repair and improve conditions in and about the mines.

Fig. 2. Barn Before Coating

Fig. 3. Barn Coated With Cement by Cement Gun

Columbia School of Mines

When the Fiftieth Anniversary of the founding of the School of Mines of Columbia University is celebrated, on May 28 and 29, at the university, the greatest gathering of engineers in the country will probably be seen. The evening of May 28, will be devoted to a reception at the university. On the morning of May 29, there will be a meeting in the gymnasium at which honorary degrees will be granted and there will be talks on modern engineering by well-known engineers. In the afternoon the first lecture in the Chandler Foundation by a distinguished chemist, will be given, and the celebration will close with a banquet at the Waldorf-Astoria, where eminent alumni will speak.

Safeguarding Electricty in Mines

*By W. E. Freeman**

Almost as soon as it was realized that electrical machines could be employed as motors, electricity was brought into use as a motive power in mining. Electricity possesses the great advantage that electric motors are highly efficient, simple, and reliable.

The principal objection against the use of electricity is, that it introduces a source of danger to the workmen about the mines. This always should be borne in mind when an electric installation is made.

In the year 1912, the reports from the various mines in Kentucky showed that there were six deaths and four non-fatal accidents due to electricity, and in the year 1913 there have been reported up to the present time, three deaths and fourteen non-fatal accidents.

Of the nine fatal accidents reported in 1912, and up to the present time in 1913, all were due to the victims coming in contact with a trolley or other uninsulated live wire. Judging solely from the manner in which the accidents have been reported, it seems evident that there would have been no deaths from electrical causes in the mines of Kentucky during the last 2 years, if the electrical systems in the mines in which these accidents occurred had been properly insulated and maintained.

In the use of electricity for any purpose and especially in mines, there are three general principles that always should be observed:

First. The electrical plant should always be treated as a source of potential danger.

Second. An electrical plant should be of thoroughly good quality and so designed as to insure immunity from danger by shock or fire, and periodical tests should be made to show that such a state of efficiency is maintained.

Third. The entire electrical installation should be under the charge of competent and skilled men.

A quite prevalent and erroneous idea is that shocks produced by low voltage systems are harmless. In some mines, high voltage wires are labeled with a plate showing a lightning stroke or skull and crossbones, thereby scaring all who come in close proximity to the line into showing it proper respect, while low voltage lines not marked are installed in a manner and handled with a familiarity that breeds contempt, and accordingly the idea of many of those who come near to such circuits is that they are harmless. This idea of harmlessness of a low voltage system is in direct disregard of one of the fundamental laws of electricity; namely, that the electric current which flows through any conductor, while directly proportional to the voltage, is also inversely proportional to the resistance. In other words, a low resistance means a heavy current to just the same extent as a high voltage means a heavy current, and it is the current that counts. It is the passage of the current that causes the electric lamp to glow, or the motor to haul the load; it is the current that causes the blinding flash when a short-circuit occurs, which flash will injure a person who is near enough to it, and it is the passage of the current through the body that kills. Some bodies have less resistance than others; hence, a low voltage will kill some people or injure them, while it will produce nothing more than an unpleasant sensation to others.

Furthermore, the resistance which is offered to the passage of an electric current through the human body depends upon the manner in which the contact is made between the body and the terminals of the circuit. The larger the area of the contact, the less the resistance and consequently the greater the current and the more severe will be the resulting shock. For example, a contact made through the lamp on a miner's cap and a trolley wire offers little resistance to the passage of the current. The soles of a man's shoes, if they contain nails, especially if they are damp, will make very good contact with the ground. Moisture on the skin at the point of contact has a great influence on the resistance of the contact. A person might touch the terminals of an electric circuit with his dry hand, particularly if the skin is fairly thick, and feel no sensation whatever, while if the skin should be moist he would receive a severe shock.

I do not mean to say that a low voltage system is as dangerous as a high voltage one, but wish to impress the fact that low voltage systems should be insulated and protected from accidental contact with any part of a person's body who may be passing or working in the neighborhood of the circuit. The current, where several of the fatal accidents occurred in the mines of Kentucky during the last 2 years, was 250 volts. It is true that many contacts are made with systems of this and higher voltage without injury, but when the conditions are right, 250, and even 110, volts will produce death. Trolley wires must of necessity, be bare but they can be protected from accidental contact by placing boards on each side that extend below the wires, the two boards being not over 3 or 4 inches apart. The principle that a wire, no matter how well insulated, should be treated as bare, is one of the rules of the National Board of Fire Underwriters, and there is every reason for its observance in mining installations, as the danger in this case is to human life rather than damage to property by fire.

Armored cable is about the best conductor for use inside the mine, so far as operation and freedom from accidents are concerned. The armor of the cable should be effectually grounded at frequent intervals so that if the conductor should come in contact with the armor, a person standing on the ground and touching the cable will not be shocked.

*Professor of Electrical Engineering, State University of Kentucky. Abstract from paper read before the Kentucky Mining Institute, Lexington, Ky., December 8, 1913.

Iron pipe is not a satisfactory protection for wires in a mine as it is practically impossible to prevent its rusting and eventually forming a contact between the conductor and the pipe. Furthermore, as pipe is not flexible, any movement of the ground will likely cause serious damage to the system.

Weatherproof insulated wire is good for underground transmission, as it resists the action of water and moisture well and will last a long time. It is better than rubber insulation for this purpose, inasmuch as rubber loses its insulating qualities rapidly in the presence of moisture, especially if the moisture contains acid.

When there is considerable acid in the water and moisture of a mine, some acid-proof insulation should be used on the wires.

The conductors, however they may be insulated, should be attached to porcelain supports, and whenever there is any liability of their being subjected to mechanical injury or of their coming in contact with some person's body, they should be covered in some effective way.

The frames of all electric machines that are ordinarily used inside of a mine, should be grounded. The electric circuits of the machine may, under some circumstances due to wear or to some accident, come in contact with the frame, in which case a person touching the frame and the ground at the same time, would receive as severe a shock as if he should touch one of the machine terminals and the ground. A good ground can be made by means of a copper plate, 3 or 4 feet in area, buried in a damp place with 2 feet of crushed coke above and below it. If the ground is dry in the neighborhood of the plate, it should be frequently and thoroughly watered.

Where there is any possibility of gas being present in sufficient quantities to become ignited by a spark, the motors should be of the "explosion-proof" type. So far as known, there is no motor on the market that is absolutely explosion proof, but there are several whose safety qualifications are based on the principle of the Davy safety lamp. The motor is entirely encased and provided with some device for relieving the pressure due to any explosion of gas which may occur on the inside of the case, without allowing the hot flames to pass outside and ignite the gas in the neighborhood of the motor. The protective devices usually consist of some method of cooling the flames before they reach the outside atmosphere. The only really safe type of motor to use in order to avoid the possibility of its operation causing an explosion of gas or coal dust, is the alternating-current squirrel-cage induction motor. In this type there is no tendency whatever toward the production of a spark. The machine, while not quite so satisfactory under conditions requiring a variable speed or a heavy starting torque, still gives good results, and inasmuch as it is absolutely safe so far as causing explosions is concerned, its use should be encouraged.

Oil-break switches should be used wherever there is a possibility of gas being ignited by a spark, which always results when the passage of an electric current is interrupted by the opening of an ordinary switch.

To summarize, the following are the points that should be given particular consideration in an electric installation in a mine in order to prevent accidents:

1. All wires, wherever possible, should be well insulated.

2. All wires, no matter how good an insulating covering they may have, should be supported and protected from any accidental contact with workmen in the same way as if they were bare.

3. All wires, such as trolley wires that must necessarily be bare, should be so guarded that no one can accidentally come in contact with them.

4. The armor of cables and the framework of electrical machines should be positively grounded.

5. Motors, switches, and other electrical appliances used where gas or coal dust may, under any circumstances, be present in sufficient quantity to become ignited, should be of a type free from sparking or else they should be so arranged that the ignition of any gas that may get within the apparatus case will not cause an explosion to extend outside of the case.

Then and Now

Some 30 years ago when conditions in the anthracite fields of Pennsylvania were different than they are today, when many collieries were operated by individual firms or small corporations, when "company stores," some of which were of the "pluck me" type, were in existence, the following incident occurred:

At one of the collieries operated by the Philadelphia & Reading Coal and Iron Co., a mining engineer was walking up a convenient and easy traveling way with his transit on his shoulder. "Captain" Burke, one of the old-time Irish characters, now seldom seen, who was employed as a miner, was also going to the surface.

As the traveling way was between 350 and 400 feet long, with an inclination of about 20 to 25 degrees, there were numerous landings for resting places. The old "Captain" was in a bad humor for some cause or other, and at every landing he vigorously swore at the "Readin' company."

Finally the mining engineer, at one landing, turned to Burke and said: "Captain, how long have you worked for the Reading company?"

"Ivver since they've had the place."

"That's about 9 years, isn't it?"

"Yis, about that."

"Where did you work before that?"

"I worked here for———— and ————" (mentioning a firm name).

"Where did you buy your grub, clothes, household goods, and things of that kind, when you worked for them?"

"At the company sthore beyant in Jackson's. Sure, I wouldn't be let dale anny place else."

"How much did———and——— owe you when they failed?"

"A month's wages, sor."

"Did you ever get any of it afterward?"

"Divil a cint."

"Where did you work before that?"

"Right here for the———— and ————Coal Co." (mentioning a small corporation)

"Where did you buy your necessities then?"

"At the same place, beyant in Jackson's."

"How much did they owe you when they failed?"

"A month's wages."

"Did you ever get any of the money later?"

"I did not."

"Well, now, Captain, has the Reading company ever let a pay day go by without paying you?"

"They have not. Shmall thanks to thim."

"Where do you spend your pay—where do you deal now?"

"Wherever I d—— plaise. Sometimes in wan sthore and sometimes in another. Whereiver I can get what I want the chapest."

"What rate is the Reading company paying now?"

"The basis."

"What are the individual operators in the valley paying?"

"Four per cint. below the basis."

"How's the ventilation here; what is the condition now as compared with what it was before the Reading company took it?"

"Oh, the vintilation is foine now. The mine is betther and more comfortable since they've had it."

"Well, Captain, by your own statement you are infinitely better off working for the Reading company than you were before. You are paid cash. You can deal wherever you please, you are getting better wages than the individual operators are paying, and you are working under safer and more sanitary conditions. What kick have you against the Reading company?"

"Well, ids a——— ————carparation, annyhow."

Old "Captain" Burke has been dead many years. He was illiterate, and filled with a prejudice that in a man of his type and few advantages, while wrong, could be excused.

There is no excuse for men of at least some education—men who profess to be intelligent—allowing agitators and sensational, irresponsible news writers to prejudice them against large industrial enterprises simply because they are corporations.

Model Coal Mine in National Museum

A working model of a colliery and coal mine is operated daily for 5 minutes every half-hour in the new Division of Mineral Technology of the United States National Museum at the Smithsonian Institution at Washington.

On account of its size and completeness and the variety of its operating parts, adult visitors will find it intensely interesting and an accurate representation of a colliery in operation.

To illustrate the preparation of coal for market and for making coke this large miniature colliery was devised. It occupies a space of 30 ft. × 40 ft., and is one-twelfth the actual size of a certain mine, reproduced with every detail faithfully represented down to the railway spikes. All of the parts are mechanically operative and the buildings are illuminated just as in actual practice. The model is a gift of the Consolidation Coal Co., of W. Va., and reproduces the conditions of that company's mine at Fairmont. A small electric haulage locomotive makes periodic trips in and out of the mine. Loaded cars are run upon an automatic dump in the tipple, arranged beneath which is a system of gratings and screens, which separate the coal into its various sizes of lump, egg, nut, and slack. The larger sizes are all loaded directly into waiting freight cars, but the slack, since it contains impurities which must be separated from the fine coal before coking must be cleaned. The mechanical separation of the slack coal from its impurities is made in the washery by jigging.

An equipment for the use of the washed coal in the manufacture of coke, is shown by a row of beehive ovens with all their appurtenances, the charging with coal of one of these ovens, and the withdrawing of the resulting coke from another. This lump coke may be loaded directly into the freight cars, or first treated in a crushing and sizing building, which is also shown in operation. Not only the colliery buildings proper, but the power house, boiler house, railroad yards, office building, superintendent's house, and miners' cottages are included.

In addition to the direct mining and marketing of coal for industrial and household use, an enormous industry has developed in the manufacture of a large variety of coal products, extending all the way from gas, coke, and tar, to drugs, photographic chemicals, and rare compounds. To a great extent this industry is incidental in the manufacture and supply of illuminating gas for household use. A series of models and samples is now being developed showing the process involved in the illuminating gas and by-product industry, together with exhibits of the products secured. There will be shown a 200-pound lump of coking coal, with the proportionate amount of gas, tar, ammonia, and drugs obtainable therefrom, as well as a model of a by-product plant in which the process is carried on.

The geological occurrence of coal is represented by a model of the Takashima field in Japan, a gift of the Mitsu-Bisbi Co. This field was selected owing to its two-fold interest; it not only serves primarily to illustrate the occurrence of bituminous coal in general, but is also unusual in that the mining operations are actually carried on under the ocean. Another model, that of the Jenny Lind mine in Arkansas, presented by the Western Coal Co.,

represents the general layout of a whole mine, but while showing much greater detail than the foregoing model, it does not indicate the coal working practice. This is reserved for the third model of the colliery of the First Pool, No. 2 mine of the Pittsburg Coal Co., Willock, Pa., which serves to bring out clearly in a popular way, the details of the various steps from the first opening up of the seam to the removal of the last available coal in that area, showing the mining town, surface plant, and workings below ground.

The exhibits of the Division of Mineral Technology are to occupy the southwest quarter of the older Museum Building, their purpose being to represent by models and specimens each of the industries based on the mineral resources of the world, covering not only current practice, but also the historical development of these industries.

Priming the Shot

Several large contractors on public work use two exploders instead of one when firing large blasts, so that in case one exploder misses fire, they can connect the other and fire. This saves the danger, expense, and time involved in drawing the tamping and repriming the shot. There is a right and wrong way in making primer cartridges and inserting them in the holes. Frequently consumers of explosives have noxious fumes to contend with after a shot because the fuse sets fire to the explosive; and further, they find unexploded dynamite in the material broken. When this occurs the explosive is condemned when, as a matter of fact, it is mostly due to the method followed in making the primer cartridge and loading the explosive in the shot hole.

The right way of inserting the cap and fuse in dynamite or other detonating explosives is shown in Figs. 1 and 2.

Fig. 1 shows the proper method of inserting and tying blasting caps and fuse in cartridges for primers. Fig. 2 shows the proper position for the primer cartridge in the shot hole. These positions insure that the full force of the blasting cap will act directly through the center of the charge, and by so doing obtain the full efficiency of the explosive. This

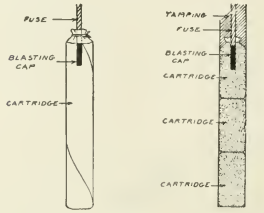


Fig. 1 Right Way Fig. 2

method of inserting the cap in the primer eliminates all possibility of the burning fuse igniting the charge before the fire reaches the detonator, a feature which prevents noxious gases and the possibility of the entire charge not being detonated. It has been assumed that if the cap was placed near the center of the charge as shown in Figs. 3 and 4, the detonation would be more effective and discharge the explosive both ways, up and down. The action of dynamite is quick and the action of the detonator is always greatest in the direction toward which the bottom of the cap points because the

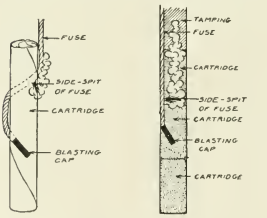


Fig. 3 Wrong Way Fig. 4

fulminate is concentrated at that place. It is not, therefore, good policy to point the cap in any direction except through the center of the charge with the primer cartridge at top if fuse is used.

Fig. 3 shows the fuse laced through the cartridge and Fig. 4 shows the fuse placed alongside of the cartridge, positions which will set fire to the explosive, if the fuse spits; and in any case the cap is not in the proper place to produce its full detonation of the charge.

The *Dupont Magazine* kindly loaned The Colliery Engineer the cuts to illustrate these, the right and the wrong methods of inserting caps in a primer, as the Dupont firm is as vitally interested in promoting safety in the mines as in producing efficient explosives. Walke, in "Lectures on Explosives," says: "Fulminate sets up a form of motion or vibration to which other bodies are sensitive." "In the case of detonation the laws governing chemical action fail to account for all the phenomena accompanying explosive action . . ." and that "detonation is the result of a combination of true chemical and dynamical reactions, neither of which alone suffices to explain the attending phenomena." If the transformation were due to mechanical shock, then it would follow that the most powerful explosive would be the best detonating agent; this, however, is by no means the case, since a few grains of fulminate of mercury in a cap will detonate gun cotton, whereas nitroglycerine, although possessed of more explosive force, will not do so unless used in large quantities.

The committee on "Steel versus Iron Boiler Tubes," appointed by the International Boiler Makers' Association, reported that they had investigated the subject thoroughly and obtained data from many sources, but were unable to find that either material is favored to the exclusion of the other. The greatest number reported that as far as actual service is concerned steel tubes give just as good service as iron tubes, and vice versa. No difficulty is found in welding steel tubes, provided an oil furnace is used. With an open coke or coal fire some trouble is experienced, due to the impurities in the fuel.

Benzine Locomotives

The Results of Two Years of Practical Experience in Their Use in Belgian Coal Mines

By A. J. Baijot*

IN Belgian coal mines machinery is being introduced to perform the work which formerly seemed to be monopolized by hand labor. Among the more prominent mechanical operations is that of transportation. The breaking down of coal is the main operation in mining and with abundant ventilation in all places and a well devised transportation system there is some guarantee of success in a mining enterprise.

Besides traction by means of horses, which will remain, as long as the coal industry exists, rope haulage, once very generally employed, seems to have been superseded by locomotives, operated by electricity, by benzine, or by compressed air. The use of these machines in the Belgian coal field is progressing rapidly.

The economic unit in any kind of transportation seems, at first sight, to be the price of the ton-kilometer; in my opinion, it is only one side of the question; the action of transportation on the net cost of coal is evident in other ways. Is it not upon the haulage system that the foreman on coming home after a hard day's work throws the blame for all his troubles: "The rope does not work"; "the cars get off the track at a certain place, or at a certain crossing"; "one horse refuses to work"? These and similar apparently trifling occurrences result in a surprising loss of money and an enormous degree of worry. Not only must the transportation system be economical but it is especially important that it be sufficiently powerful to keep cars at the working face and away from the shafts.

From this explanation of what a motor should do it is proposed to analyze the cost of haulage per ton-kilometer with benzine locomotives, and the conditions to be fulfilled, that transportation may be reliable.

*Engineer at the collieries of Bois-du-Luc. Translated from Annales Des Mines De Belgique, Vol. XIII for The Colliery Engineer.

34-10—5

The expenses for one shift, 9 hours, or 32,400 seconds, are divided in two parts: one, variable with the work done, comprises the consumption of benzine and lubricating oil; the other a fixed charge, depends on the wages paid and the depreciation of the installation, etc.

The 12-horsepower locomotive most generally found in the Belgian

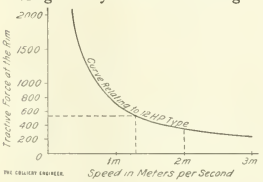


Fig. 1

mines furnishes a speed of 2 meters* a second, therefore these remarks are confined to a locomotive of that power.

The consumption of fuel and oil follows complicated rules impossible to satisfactorily analyze, and considering the purpose and scope of these remarks the error will not be important if an approximate law is determined by the relation between the consumptions in the following extreme cases:

1. The motor is working, but the locomotive is not in use.

2. The machine develops, during the whole shift, its normal 12 horsepower without any stop, on a well-built road with good rolling stock. The work accomplished is calculated as follows:

The effort of traction at the tread of the wheel T is shown in the formula $T=\frac{N\times 75\times R}{V}$, N being the power, R the mechanical efficiency produced, V the speed; this effort becomes larger as V decreases. The curve, Fig. 1, gives the relative values of these two factors for a locomotive of 12 horsepower, supposing R = .80. An inferior speed limit exists under which the effort of traction T on the circumference of the wheels takes too large a value in relation with the weight supported by these wheels; the machine then slips. In the present case it is admitted that this value is about $\frac{1}{8}$ of the weight of the locomotive, that is, T max. $=\frac{4,500}{8}=563$ kilograms, corresponding to a speed of 1.28 meters. On account of these different considerations, the speed of 2 meters a second has been admitted as the most advantageous; it is far enough from the critical speed to make allowance for the starting, and wet tracks. The figures are acceptable, and without danger, for the entries of the mines.

*6.54 feet.

The total weight pulled is L (locomotive) + M (dead weight) + P (useful load); the equation of the effort at the circumference of the driving wheel is written as follows: $T=(L+M+P)\ (f\cos\alpha-\sin\alpha)$.

The angle α is always very small and the expressions can be made $\cos\alpha=1$ and $\sin\alpha=\tan\alpha$; this last term may be represented by $\frac{m}{1{,}000}$ (m being the grade of the tracks expressed in millimeters to the meter). Therefore

$$T'=(L+M+P)\left(f-\frac{m}{1{,}000}\right)$$

If empty

$$T''=(L+M)\left(f+\frac{m}{1{,}000}\right)$$

In case of a well-balanced road these two values are equal:

$$T'=T''=(L+M+P)\left(f-\frac{m}{1{,}000}\right)$$
$$=(L+M)\left(f+\frac{m}{1{,}000}\right)$$

Hence, $m=f\frac{1{,}000\ P}{2L+2M+P}$

In a general way it is admitted that the dead weight M is equivalent

to .45 of the useful load and that the locomotive represents .15 of it; therefore

$$m = f\frac{1{,}000\ P}{(.3+.9+1)P} = \frac{1{,}000}{2.2}f$$

The coefficient f would be satisfactory if it were represented by $f = .01$; in this case

$$m = \frac{1{,}000}{2.2} \times .01 = 4.5 \text{ millimeters}$$

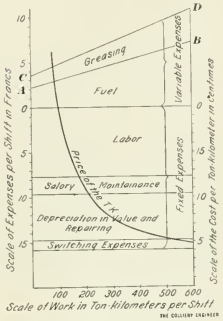


Fig. 2

The balanced rolling would be realized on a track presenting a grade of 4.5 millimeters to each meter.

Take again the equation of the effort of traction in the case of a load,

$$T' = (L+M+P)\left(f - \frac{m}{1{,}000}\right);$$

replace L by 4,500 kilograms and the other terms by values previously determined, then:

$$T' = (4{,}500+.45\ P+P)\left(.01 - \frac{4.5}{1{,}000}\right)$$

$=360$ kilograms, hence $P = 4{,}200$ kilograms.

During the 32,400 seconds of the shift, the machine will go over (32,400 × 2) meters, being loaded on a half of this distance, that is, 32,400 meters. The work expressed in ton-kilometers in these ideal conditions would reach the figure of 42 × 32.4 = 1,350 ton-kilometers in round figures.

In case (1), the builders allow less than 1 kilogram of benzine an hour; say 9 kilograms per shift; in the second case, consider .5 kilogram per horse-hour, that is, .5 × 12 × 9 = 54 kilograms per shift.

For the work accomplished, it is, in one case, 0 ton-kilometers, and in the other, the calculation made as above establishes it as being 1,350 ton-kilometers.

From that, it follows that the maximum consumption of fuel by the machine when running stationary is equivalent to six times that of the machine when running. In practice the locomotive will never furnish more than 600 ton-kilometers per shift, and diagrams of the net cost will be made according to this figure, and the line of consumption of fuel will be drawn, supposing that for 600 ton-kilometers, this consumption is 3.2 times more than when the machine is stationary. While this assumption is not absolutely exact, it is a means of tracing approximately complete curves of the net cost.

The line $A\,B$, Fig. 2, is in relation with the axis $o\,o$, and by the use of a proper scale the ordinates would represent francs instead of kilograms.

The same method of reasoning may be repeated for the expense of lubrication and in the same proportions; if therefore this value is carried above $A\,B$ the line $o\,D$ is obtained.

Under the axis $o\,o$ of Fig. 2, write down the fixed expenses for one shift: labor, switches, depreciation in value, etc.

These elements allow the tracing of the curve of the ton-kilometer in function of the work accomplished.

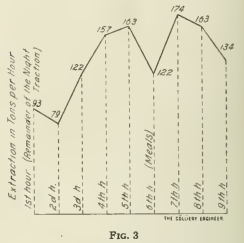


Fig. 3

This diagram shows under an abridged form the complete economical problem of transportation, namely that, in order to reach a reduced price for the unit, it is necessary to bring the commercial speed of the machine to its maximum, to have it pull cars as heavily loaded as possible, and finally to reduce to a minimum the fixed and the variable expenses.

Causes That Have an Influence on the Commercial Speed.—A locomotive does not run 9 hours without a stop; a haul is made a certain distance L; the locomotive is uncoupled from the train, to be placed at the head of the trip to be taken in the opposite direction. If m is the time in seconds necessary for this change of position at one end of the haul, and m' the time needed at the other end, the maximum time during which the machine will run will be

$$\frac{32{,}400 \times 2L}{2LV + m + m'}$$

This formula shows the advantages of long hauls; it indicates also that the times m and m' must be reduced to their minimum. The easiest way to accomplish this is to arrange the tracks as shown on the left of Fig. 4, where the motor when reaching the switch is uncoupled, and sent to

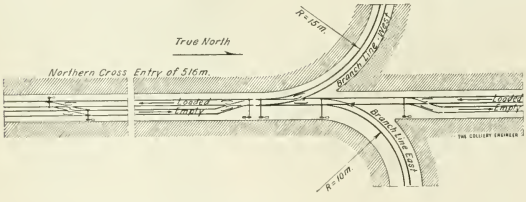


Fig. 4

the switch at the head of the other section; such a change in position may take 15 seconds.

The inconvenience of this arrangement is that the trip is left behind the trip in front; if both consist of 40 cars measuring 1.30 meters each, the last car remains at a distance of 120 meters from the crossing ending the double tracks. In the working faces it is, however, the best system. If it is desirable to place the two trips facing each other, as is often the case near the shafts, three tracks are necessary. The shifting of the locomotive's position will then take about 70 seconds. In certain special cases circumstances necessitate more complicated changes of the locomotive's position, giving to the factors m and m' more importance.

In order to cool the motor cylinder and to sprinkle the exhaust gases the locomotive carries a supply of water which becomes gradually exhausted and warm, and has to be replaced from time to time. With certain kinds of benzine locomotives it is necessary to take water every trip; with others it is sufficient to change the water three times during a shift. The loss of time in taking water may be considered as 20 to 30 minutes for each shift, if the place for taking water is judiciously chosen.

Attention is called to the fact that the speed of 2 meters a second is not immediately obtained at the starting of a load but is obtained slowly and progressively, not only to spare the locomotive but also to avoid breaking the car links or pulling out the drawheads. The diminution of the commercial speed resulting from these causes becomes more important as the distance of the haul becomes shorter.

It has been assumed in the ideal case of maximum work, that the total duration of traction was 9 hours; but there is the putting the motor to work in the morning, then meal time, and then the return of the machine to the locomotive barn, all of which represents *at least* half an hour of the time lost during which no haulage is being accomplished.

Finally, the mining is not continual during the whole shift; as may be illustrated in a general way by a curve of the kind shown in Fig. 3, which refers to a place where 500 tons are mined and is traced in accordance with average figures of a monthly report. It is possible to find collieries more regular in their output, but many show greater variations.

It is necessary that the locomotive shall be sufficiently powerful to move the maximum production; consequently the machine is larger than the average work of the shift demands; this causes a diminution of the commercial speed.

The condition of the tracks must be considered; they may be too wet, their grade too steep or not steep enough, which will cause diminution of speed.

Besides the reasons stated, there will be stops on account of accidents, of which the most important is that the cars, and sometimes the locomotives, get off the track.

Unless the track has been very much neglected, a locomotive gets off the track only at the switch, when it is not kept in good repair. To replace it on the track, screw jacks, levers, etc., are used. Probably the quickest and easiest method, when there are several motors in service, is to prepare a rolling way with some pieces of wood and to pull the machine that has run off the track, by means of another one, toward the point of the switch; this operation, which is always successful, does not require much time.

To the causes that reduce the commercial speed of the machines, it is necessary to add an important one produced by the stops, at the partings where trips are formed. Taking into consideration all the above-mentioned drawbacks to speed, if a locomotive is able to produce 300 ton-kilometers, it will need help as soon as this figure is exceeded; then the number of machines is too large and every one is not constantly in use. The same thing happens when the transportation is complicated; if trains of cars are collected in five or six working places it will be impossible to send the locomotives to each of those places at the exact time when the trip is made up; it will frequently happen that a locomotive on reaching the parting will have to wait a comparatively long time before being able to hook to a trip and it will happen, on account of this detention, that several locomotives will reach the shaft at the same time, and must necessarily have to wait, until the trip ahead is in the cage, in short, for a given quantity of work the necessity of a larger supply of rolling stock increases with the number of the branch roads used for transportation.

The lack of cars, the roof falls in the drifts, the accidents in the shafts, all cause momentary stops, for which it is necessary to make up time later on.

Causes Which Have an Influence on the Tonnage.—The useful load of 42 tons was calculated supposing that the locomotive developed its effort of 360 kilograms corresponding to 12 horsepower. This is a limit which cannot be reached when the machine is working normally, because when starting it needs an additional power to overcome the inertia of the train, and to communicate speed to it.

The formula of the inclination to be given to the tracks, to obtain a well-balanced rolling, has been given as $m = \frac{1,000}{22} f$; the inclination to be given to the track increases with the resistance offered by the cars. Using roller bearing wheels, it has been found that $f = .012$, after a large number of experiments by the method of the inclined plane. The results show that the track inclination for roller bearing wheels should be 5.5 mm. to a meter. Practically the best results were obtained with an inclination of 7 mm. to a meter;

this arises from the fact that the real coefficient f is larger than the one found in the experiments; because some cars are worn, their wheels rub against the sides, or the rails are covered with dust or mud; in the damp places the batter of mud formed along the rails necessitates the wheel flanges plowing through it and these items largely increase the track resistance.

In spite of all the care with which the tracks may be built, it will never be possible to obtain a uniform inclination and maintain it, especially on the secondary lines, where the ground is unstable.

The additional resistance at the switches and on the curves is also to be accounted for. Finally, in the mines, coal and rock are transported and the density of the latter is about 1.5 times that of the coal. The number of cars composing a trip being invariable, the result is that the locomotive will have to be, under the circumstances, powerful enough to pull the trip of cars when loaded with dirt, therefore, during its normal work, it will not be working with a full load.

With the 12-horsepower locomotive running at a speed of 2 meters a second, trips of 32 to 40 small cars are generally adopted (40 small cars loaded with dirt represent about 30 tons) according to their weight, the type of wheels, the average inclination of the tracks, etc.

Work of the Locomotive.—The work of the locomotive in ton-kilometers results from the combination of the commercial speed with the tonnage by sections. Mr. Hellez reports an experiment of 404 ton-kilometers per shift on a distance of 600 meters; many examples will reach 250 ton-kilometers; finally the limit may be 125 to 150 ton-kilometers, on account of special conditions.

Consumption of Fuel.—The law of variations of the consumption of benzine in function of the work in ton-kilometers may be considered as near enough to illustrate the net cost of the ton-kilometer. The most variable factor in this consumption is the price of the benzine; in April, 1910, the price was 18 francs per 100 kilograms; in July, 1912, the price reached 30 and even 37 francs per 100 kilograms.

Lubrication.—In this case it is necessary to have a good oil for lubrication on account of the high

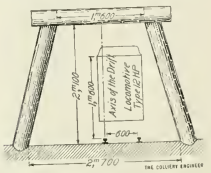


Fig. 5

temperature of the cylinder, and of the great speed of the different parts. The price of the oil per kilogram will be about 60 centimes.

Salary for the Keeping in Good Condition.—A good mechanic, intelligent and industrious, is necessary to keep the locomotive in good working condition; therefore it is important to select him carefully. The duty of this mechanic will be to frequently and minutely examine all the parts of the machines, to clean them, to lubricate them before beginning to work, to polish the valves periodically, to clean the ignition plugs and the magneto at the proper time, to regulate the distribution; to keep the joints in good order, and do the repairing necessary. A man can

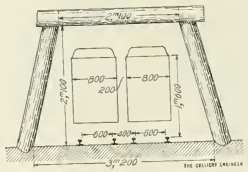


Fig. 6

keep six locomotives in good condition; if his salary is six francs a day, it will mean one franc per machine and per shift. When an installation consists of less than six locomotives, the mechanic may be kept busy with some other work. It is also necessary to take into account the salary of the special watchman provided by the Belgian regulations to accompany the car tank containing benzine from the time of its leaving the surface of the ground until its return. This watchman must fill the tanks himself. In an installation consisting of six locomotives, this item may be counted as .25 franc per day and per machine. As a total the salary for the keeping of the machine in good condition will be near 1.25 francs.

Labor.—A locomotive at work calls for two men, a driver and a trip runner. When the transportation is not very complicated, the service of a switchman is useless, but when there are several drifts, in which several locomotives are at work, it is necessary to have at the point of junction a man to send them in the right direction; this work will be more or less important, according to the circumstances.

Depreciation in Value and Keeping the Material in Good Condition.—A locomotive costs about 9,000 francs. The depreciation in value in 10 years and the interest at 5 per cent. of the capital represents an annual amount of 1,350 francs. If the machine works during a shift every day, that is 300 shifts a year, the depreciation value will amount to 4.5 francs for a shift. Generally 5 francs is counted to cover also the pieces of machines to be changed in order to keep them in good condition.

It is absolutely necessary to have one machine resting for 3 or 4 working. If they work one shift only, it is necessary to have some additional ones; therefore each accomplishes less than an average of three hundred shifts a year, and the depreciation in value of the material must be increased accordingly.

If the service is divided between several shifts, a sufficient reserve can be secured by having as many machines as are necessary for the service during one day (for a transportation using three locomotives in the morning and one at night,

four will be necessary); every one of these machines working during an average of 300 shifts the amount for depreciation in value on each, will be calculated as indicated above.

Finally, in case of two shifts working heavily, the average service may go over 300 shifts a year, although keeping a reserve (for instance, for three locomotives for the day and three for the night, five will be sufficient); the amount for depreciation in value will be diminished accordingly.

Is it advisable to include in this item the depreciation in value of the accessories necessary for the use of the locomotives—houses, widening of the tracks, stables, etc.? No, because the expenses for constructing the stables are not included, when

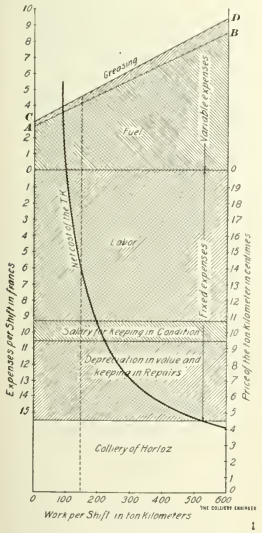


Fig. 7

transportation by means of horses is figured. It would be often difficult to know where to draw a line; in fact the expenses for one and the other means of transportation are balanced; a barn for horses costs as much as a stable for locomotives; and the size of the drift sections required by locomotives is the same as that necessary for horses or ventilation. The two types of drifts illustrated in Figs. 5 and 6, are recommended, unless larger sections be required on account of the ventilation or of the custom; the first drift is 1.6 meters wide at the top, gives a sufficient space for the safe movement of the employes at the side of the machines when running; the second drift 2.1 meters, is recommended for stables for double-track shifts where several machines are at work.

Some Examples.—Mr. Fourmarier, engineer, has published a study on the work of a benzine locomotive at the Colliery of Horloz which gave the data necessary for the diagram of Fig. 7. However, to this has been added the salaries for maintenance, transporting the benzine, etc., according to a rate previously determined, that is, 1.25 francs for a shift. It is possible that during the time of the experiment no expenses for maintenance were required, but in order to establish an average net cost, it is necessary to include in these expenses the average value which would be shown by the experiment of several years. The report does not give the weight or the price of the benzine consumed. It is likely, considering information received about its consumption, that this price was about 18 francs for 100 kilograms. For a work of 150 ton-kilometers that the machines produced here, the diagram shows a net cost of 13.3 centimes, a little above that resulting from Mr. Fourmarier's table, on account of the addition of the salary for the maintenance of the machines.

Mr. Defalque, engineer, gives on the locomotives used at Ressaix information from which the diagram shown in Fig. 8 is drawn. In establishing the net cost, salaries for maintenance and transportation of benzine, etc., are not included and are assumed as before to be 1.25 francs. Mr. Defalque assumes 6.35 francs as the depreciation in value, which is reduced to 5 francs to conform with the preceding data. The report mentions only one man for one machine; it is possible that the trip runner is normally charged

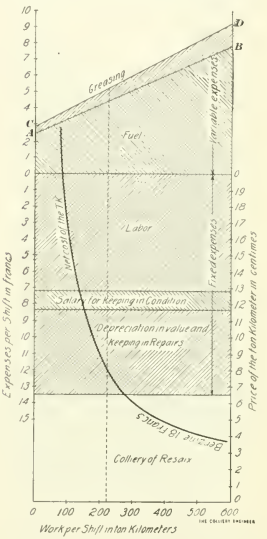


Fig. 8

against another item in the bookkeeping of the colliery; therefore a trip runner is added at a salary of 3 francs. The benzine in this case cost 18 francs for 100 kilograms. The price of the ton-kilometer reaches, on the diagram, 8.34 centimes for a work of 225 ton-kilometers per shift.

Mr. Hallez reports in a "Note on the traction by means of benzine at Havré belonging to the Collieries of "Bois du Luc," the elements of the price of the ton-kilometer for two experiments, one of three, the other of 4 months. It is the average resulting from these 7 months that has been used as a basis to trace the diagram of Fig. 9. The price of the benzine reaches 22.40 francs for 100 kilograms as an average; the ton-kilometer costs

10.8 centimes, each machine making 204 ton-kilometers per shift. This net cost is not compatible to the precedent, on acount of the high price of the benzine; in case it had cost 18 francs, the variable expenses

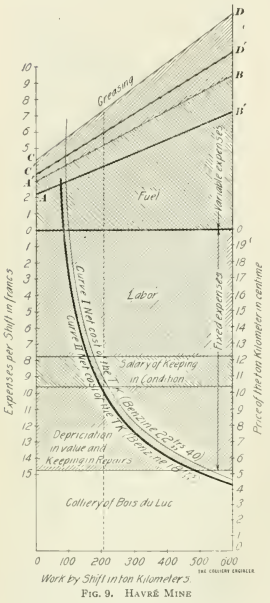


Fig. 9. Havré Mine

would come down to *A' B'* and *C' D'* and the curve of the net cost from I to II.

Finally these different results are compared with those at Quesnoy, shown in Fig. 10. In this curve the fixed charges include the salaries of two switchmen, but the experiment was made when the benzine cost 32 francs for 100 kilograms. The ton-kilometer is obtained for the price of 18.7 centimes, each machine accomplishing an average of 132 ton-kilometers. To make comparisons, suppress the expenses connected with the switches and bring back the price of the benzine at 18 francs, then curve II results and may be placed near the others.

Conclusions.—The practical deductions from these diagrams are as follows:

The fixed expenses are practically the same everywhere, and depend on the salaries paid, with the exception that they increase if a switchman is required.

The variable expenses depend on the price of benzine, the consumption in kilograms being nearly identical.

The consumption of oil and grease is subject to large differences in price. The prices of Quesnoy are slightly exaggerated, but those of Havré seem to be at a normal rate. The consumption of oil shown in Fig. 8 and especially in Fig. 7, is extraordinarily low.

In a general way, Fig. 10 sums up all the problem; the curve of the net cost will be figured as in II, when the benzine will cost 18 francs; it will rise gradually with the price of this fuel to reach the values marked I, when the price will be 32 francs.

But the most important thing taught by these diagrams is the necessity of the locomotives accomplishing the largest possible amount of work; if 400 to 500 ton-kilometers are hauled the cost will be 5 to 7 centimes per ton-kilometer; in many cases 250 ton-kilometers will be hauled at the cost of 8 to 11 centimes. In case 125 to 150 ton-kilometers only can be hauled the net cost will reach 20 centimes.

Some General Considerations.—The preceding analyses show that benzine locomotives furnish to the mine owner an economical means of transportation; if, sometimes the price appears to be too high, the fault cannot be placed on the system, but on unfavorable conditions, on carelessness or lack of good management.

Besides being economical, the transportation must also be absolutely certain, because a deficient system of transportation might have a very important action on the other items constituting the net cost per ton. Compared with horses, the tonnage, transported on a certain line, is much higher; an intensive transportation which would seem the limit of the work to be furnished by horses, would be taken care of, easily and without excitement, even if it were largely increased; the regularity of the transportation will be improved; the traction instead of being made by jerks, will be easier: this will spare the couplers of the cars, even the sections are longer; tracks and switches will be cleaner: this will avoid car derailment and all the consequences resulting from these accidents. The stops on ac-

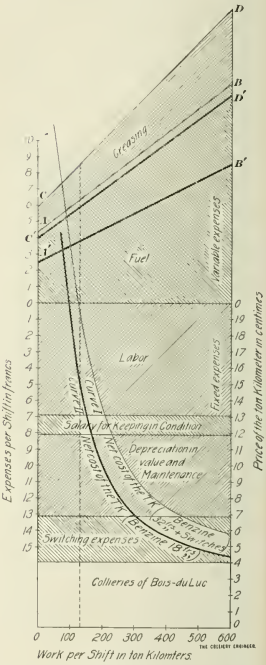


Fig. 10. Quesnoy Mine

count of indisposition, etc., which happen so frequently with horses, are unknown with locomotives; the stops during the work, necessitating an immediate return to the shed, happen so seldom that is not

necessary to take them into account. The accidents to persons also are not so frequent because, for a certain tonnage, the number of the employes is smaller, and because men can more easily manage machines than horses.

Relative to the signals to be placed on the trains when several locomotives run on the same line: when the lines have curves and branches, it would be well to place a red light on the last car of the trip; in this way the driver immediately notices if one part of his trip is separated from the rest, also if the track is obstructed by a trip which has been stopped. If some cars are left behind, he can see it, and not only material accidents are thus avoided, but also accidents to persons, which might occur if a machine ran into a train, during the time the cars are off the track.

A complete train measures from 40 to 50 meters in length and accidents of this kind might be possible. There is no need to look for a complicated system to fix this light; a lamp is hanging on the edge of the last car, Fig. 11, by means of a spring made with a steel wire rolled, the lamp can stand all the jerks at the starting points, at the stops and at the switches, etc., without going out; the trip runners make these springs with old wire from automotor plants.

In the same way, each machine is provided at the front and at the back with two lamps, one yellow, used to light the tracks, the other red, also hanging by means of springs; in this way the drivers are warned in advance of the switches in the drifts with double track. Also the employes and switchmen see the locomotives coming and take the necessary precautions to prevent accidents.

Compared with the other means of mechanical transportation, benzine locomotives have the advantage of complete independence; they perform easily and safely. They do not involve danger to the driver, or to the employes, and are fit for the sections of the drifts generally admitted in our basins. Exceptionally low figures for net cost have been occasionally quoted for certain continued haulage; they almost always referred to intensive transportation in straight lines, between two well-defined points. This haulage cost

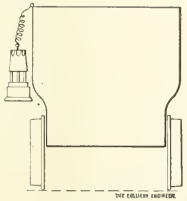


Fig. 11

cannot be compared with haulage in mines by independent motors, like the benzine locomotive, but in case it was put on work of that kind, its useful effect could reach 500 ton-kilometers, with a net cost of 5 centimes.

A point of disadvantage is the odor caused by the machine, if the ventilation is not sufficient. I believe that in a drift, it is possible to use one locomotive for each 4 or 5 cubic meters of air passing through the drift in a second. In the places where this condition is not fulfilled, the benzine locomotives would lose their advantages over compressed air locomotives.

OBITUARY

GEORGE WESTINGHOUSE

George Westinghouse died of heart disease March 12, at his residence in New York City. He was born at Central Bridge, Schoharie County, New York, on October 6, 1846.

At the age of fifteen he invented a rotary engine and passed an examination for the position of assistant engineer in the United States Navy. In June, 1863, he enlisted in the Twelfth New York National Guard and in 1864 he accepted an appointment as third assistant engineer in the United States Navy, and was ordered to report to the Potomac Flotilla, June 28, 1865. He was honorably discharged on August 1, 1865, and entered Union College, where he remained until the close of his sophomore year.

His first patent was issued April 13, 1869, for an air brake, and on July 20 of that year the Westinghouse Air Brake Co. was formed. He spent 7 years in Europe, introducing the air brake. In the meantime he invented a quick-action brake with a triple valve. In 1886 the Westinghouse Electric Co. was formed for the manufacture of lamps and electric lighting apparatus. In 1891 the various companies with which he was connected consolidated as the Westinghouse Electric and Manufacturing Co., which owns extensive works at East Pittsburg and employs over 22,000 people.

Owing to his many achievements in mechanics, electricity, steam, and gas, Mr. Westinghouse was known the world over. At the present time the Westinghouse Company employs 50,000 people on whom 150,000 persons are dependent.

JAMES B. DAVIES

James B. Davies, one of the most prominent mine officials of the Wyoming Valley (Pa.) coal field, died at his residence in Plymouth, Pa., on April 8.

Mr. Davies was a native of Brecknonshire, South Wales. He was born April 26, 1840. In 1868 he came to America and settled in Wilkes-Barre, Pa. He secured a position with the Lehigh and Wilkes-Barre Coal Co., which he filled with such skill that he was promoted to the position of inside foreman of the Nottingham colliery, at Plymouth, one of the largest mines in the anthracite region. Nine years later he resigned this position to accept the position of inside superintendent of the mines of the Plymouth Coal Co.

Five years ago, owing to advancing years, and poor health, he retired to private life.

Deprived of early educational opportunities, Mr. Davies added to the knowledge gained through years of practical experience, by careful reading and study. His reputation as a mine manager was not confined to the neighborhood in which he spent most of his life, but extended to the coal fields of Europe. He either wrote or furnished the notes for a number of valuable articles published in The Colliery Engineer and other mining periodicals, and was requested by the German Government to contribute articles to the official mining publications of that nation. For this work he received the thanks of the then Emperor and Prince Bismarck.

Mr. Davies was a man of sterling integrity and upright character. Deeply religious, he was prominent in the work of his chosen denomination, Calvinistic Methodist, and for many years was a deacon of the Plymouth church. A prominent trait of his character was his even, kindly disposition and his consistent efforts for the uplift and encouragement of deserving young men engaged in coal mining.

Science and Industry Allied

Robert Kennedy Duncan, whose death occurred a few days ago, carried out in his own career the advice he gave in "Some Chemical Problems of Today," to young scientists to apply their knowledge to the improvement and solution of industrial processes. Mr. Duncan himself, in addition to his duties at the Universities of Kansas and Pittsburg, and his writings, discovered a process for manufacturing phosphorus and new processes for decorating glass. "Why should trained and earnest men devote laborious days to making diketotetrahydroquinazoline?" asked Mr. Duncan in "Some Chemical Problems of Today," "or some equally academic substance, while on every side these men are needed for the accomplishment of real achievement in a world of manufacturing waste and ignorance?"

Notes on Mines and Mining

Reports on Conditions and Other Matters of Interest in Various Coal Fields

By Special Correspondents

THE Superior Coal Co., at Mine No. 2, Gillespie, Ill., on March 14, 1914, hoisted 5,023 tons of coal in 8 hours from a depth of 385 feet, making 1,562 hoists. This record was made with a pair of 24″ × 36″ "Litchfield" standard hoisting engines that have been in continuous service at this mine for 10 years.

The Bunsen Coal Co., has appropriated $250,000 for a new mine to be developed near Georgetown, Ill. Its capacity is to be 4,000 tons per day.

NOVA SCOTIA

The output of the mines of the Dominion Coal Co., for the first quarter of 1914 totals 1,118,000 tons, a decrease of about 73,000 tons compared with 1913. The Nova Scotian collieries are all suffering slightly from the restriction in manufacturing and railway operations which the prevailing recession in trade has brought about. Trade prospects for the summer are fairly bright, and owing to the general slackness, the coal companies have put down unusually large stock piles against the summer demand. The Dominion Coal Co., will have well over 600,000 tons in banks when navigation opens up. Labor is more plentiful than for some years past, and indications are that outputs will not be restricted by lack of men during the coming shipping season, as they have been during several recent seasons. Daily outputs up to 23,000 tons are being obtained at the Dominion Coal Co.'s mines, and this fact, combined with the large stocks and the probable good labor supply, points to the largest shipments to St. Lawrence ports yet recorded as being likely during the coming summer.

The Nova Scotian government has appointed a commission to inquire into the whole question of workmen's compensation for injury, to report particularly on the condition of the miners' relief societies now in existence in connection with coal companies exempted from the provisions of the existing compensation act of the Province, and to advise on the conditions under which these companies should continue to be exempted, or otherwise.

Some years ago the government enacted a compensation law, but on representations from the members of the colliery relief societies, the coal companies in the Province were exempted from its provisions, on the understanding that the relief disbursed by the relief societies should give as good protection to the colliery workmen as the provisions of the compensation law. All these relief societies grant relief for disablement in sickness as well as from accident, and it was felt that if the companies were brought under the act, they would withdraw their support from the relief societies, which would shortly die, thereby depriving the miners of their only safeguard against illness. Nova Scotian experience is that relief disbursed for disability arising from sickness amounts to at least twice as much as that required to afford relief in cases of disability arising from accidents sustained at work. Many of the smaller colliery relief societies are, however, not actuarially solvent, and in case of disaster involving extensive loss of life, some serious questions regarding liability might arise.

The problem of compensation for work accidents is in Nova Scotia very intimately bound up with that of affording relief in sickness. The colliery towns and villages are isolated, and are often the creation of one coal company, which affords the one means of livelihood to the com-

munity and pays probably double the major portion of the corporate taxation. There are no wealthy friendly societies, practically no poor-law relief, and the insurance societies look askance at the miners' risk. Therefore, the relief of distress, whether it arises from sickness or accident, falls ultimately on the coal company, and it is extremely difficult to separate the two causes of disability. The peculiar features of the Nova Scotian coal industry will probably render it advisable to perpetuate the present relief societies, but it may be found wise to bring them under government supervision and to require them to be brought up to a condition of solvency combined with the payment of adequate benefits.

The Coal Mines Regulation Act of Nova Scotia contains no provisions governing the installation and use of electricity in coal mines. The use of electricity is now so general throughout the coal mines of Nova Scotia that some regulation is felt to have become necessary, and a commission is at the present time working on the formulation of rules. Although the issue has been raised in some ill-informed quarters, the permissibility of electricity in coal mines is beyond question. A striking point in the evidence submitted to the commission was that electricity afforded the only solution of the extraction of the great submarine coal fields which extend outwards from Cape Breton Island. Geological indications would lead to the conclusion that these coal fields have for all practical purposes an indefinite extent. The only limitations to their extraction will be those imposed by remoteness from a land opening, such as ventilation, conveyance of power to the coal face, and the haulage of coal and men for long distances. All these difficulties resolve themselves around the economical limits of the transmission of power. Steam power is unthinkable for underground use, and compressed air has very definite limits in transmission. Electricity is the only possible solution. Some day coal may be extracted, say, 10 miles out under the sea, and if so, the future development of the vast submarine coal fields around Cape Breton Island will evolve unique and novel mining practice, in which, of course, electricity will play a leading part.

TENNESSEE

The Roane Iron Co., of Tennessee, has lately leased its mines at Rockwood to the Knox Mining Co., E. O. Wells, president, which company commenced operations at the mines April 1. There has been no change of officials at the mines.

The complete returns, which have just been compiled by the State Mining Department, show the output of Tennessee for 1913 to be 6,739,486 tons of coal; an increase of 160,732 tons over that of 1912. The total value and also the value per ton show a slight increase.

WASHINGTON

The 900-ton sample of Alaska coal mined in the Matanuska coal field of Alaska, during the past field season, is now hauled out over the 65 miles of trail and has been landed at Knik, Alaska, from which place it will be taken aboard a U. S. Navy warship and a test made during the spring or early summer.

The Carbon Hill Coal Co., is contemplating putting in a modern coal-washing plant. Percy E. Wright, of Seattle, has been engaged to install the plant along modern lines. Mr. Wright is also engaged in the same capacity with the Wilkeson Coal Co. It is planned to use a Bradford breaker at the Wilkeson plant, the first to be installed on the Pacific Coast.

The Hyde Coal Co., is remodeling its newly built bunker, and plans installing a Marcus picking table, and other modern coal-cleaning devices.

Seattle recently celebrated the passing of the Alaska Railroad bill. The public in general expect great things with the opening of the Alaska coal field. Many believe that it will materially reduce the price of coal on Puget Sound. Those thoroughly informed in the Alaskan coal situation do not agree with this point of view. Opening the Alaska coal fields will greatly aid the situation in Alaska, but will have little or no effect on coal prices outside of that territory.

WEST VIRGINIA

Messrs. John F. Phillips and Charles D. Robinson, of Fairmont, W. Va., and Senator A. Hood Phillips, will develop a tract of 100 acres of Pittsburg coal along the B. & O. Railroad, between Rosemont and Flemington, Pa. It is expected to have the tipple and power house completed and the mine in operation by July 1. The plant is to have a working capacity of from 500 to 700 tons a day.

Penna. Anthracite Section A. I. M. E.

On the evening of March 23, Mr. R. V. Norris entertained the organization committee of the Penna. Anthracite Section of the American Institute of Mining Engineers at his home in Wilkes-Barre, Pa. Following a dinner, a meeting of the committee was held and the constitution and by-laws were framed for the approval of the general meeting of the Section. It was decided to hold the next meeting of the Section on May 9.

Mr. Norris was then elected as the first president. Four vice-presidents were chosen, each of whom is to have the general direction of the Section's activities in his respective field. W. J. Richards in the southern coal field; Edwin Ludlow in the middle field; C. F. Huber in the Wyoming field and Arthur H. Storrs in the Lackawanna Valley. Charles Enzian was elected secretary-treasurer. An executive committee was formed consisting of Frank A. Hill, of Pottsville; A. B. Jessup, of Jeddo; R. J. Foster, of Scranton; Douglass Bunting, J. M. Humphrey, and R. A. Quinn, of Wilkes-Barre.

The Mineral Man

An Interesting Account of Former Times and Customs in the Mountain Regions of West Virginia

By Neil Robinson

THE West Virginia Coal Mining Institute begins its session this morning in a very serious mood. Our estimable secretary, Prof. E. N. Zern, has arranged to lead you through a maze of profound discussions relating to chemistry, salesmanship, the influence of public sentiment, scientific mining and the enforcement of the Prohibition law; we will travel to Panama, with former Governor MacCorkle; Hon. Lee Ott will tell us the story of the humane compensation law; and Governor Hatfield, for many years a distinguished medical practitioner, will speak on sanitation and the protection of health in mine villages.

A few years ago Institutes were unknown in our state.

Our gatherings were limited to political conventions, meetings of various Grand Lodges and occasional camp meetings. The individual manager and operator never visited the plant of his neighbor. It would have been regarded as impolite—possibly as spying. There was very little traveling to the so-called backwoods or "up the creek." The operator journeyed from the mine to the banking town for a pay roll and sometimes visited the general office of a railroad to sell some fuel. The motive power at the mine was mule; the best mining machine was Irish, and for ventilation we sometimes lighted a fire at the bottom of a mud-daubed frame stack proudly called a furnace.

It would be interesting to trace the development of the mining industry from these crude beginnings and make a contrast with the goal which the eminent men in our profession are now seeking to attain, but I prefer to carry you away for a few minutes from the symbols of chemistry, the wonders of electricity and the constructional work of man for a little journey to the lands beyond "the head of the creek."

*Address before the West Virginia Mining Institute, December, 1913.

I count it as a bit of rare good fortune that professional duties called me into the mountains while the men and women were still natural, the spinning wheel in use, handmade rifles in service, good old sorghum served in coffee, and celluloid collars and patent-leather shoes unknown. There was always a cordial welcome for the stranger, and many a time the head of the house has called from the door of a cabin "get off your horse and come in and warm up—you know pore folks have pore ways but we're glad to see you."

Once I entered a field that had evidently been visited by several coal seekers, for the following loudly shouted conversation took place. The man who owned the coal opening I was endeavoring to locate was plowing far down on a hillside below the ridge road:

"Hello! Are you Mr. Frank?"

"Yes; and who mout you be?"

"I am Mr. Robinson from over at Charleston in Kanawha County."

Mr. Frank made a megaphone of his hands and literally yelled back: "Air you one of them dern mineral men what goes through the country a looking at coal seams and a leavin' down fences?"

Of course it was useless to deny my guilt and we finally compromised by his election as boss of the rail-fence gang with the right to discharge himself if the work was not well done. No one was discharged.

Two days later I came to the clearing of an old settler who had been there "ever since it was a case of one blaze from home and two blazes fer home." The cabin was without a window and as we sat by the log fire our light from the open door was cut off by a tremendously large woman, barefooted and smoking a pipe, who stood on the step watching some kittens at play. My local guide looked in some surprise and said: "Why, Mr. Lotts, I didn't realize that your wife was so big—I thought she was a thin woman." The old man put his hand to the side of his mouth and said: "Smith, I reckon you're thinkin' of t'other one. That 'un was a powerful worker, but she was thin as a fence rail, but you know I traded her'n a rifle for this 'un an' a coon dog—an' 'fore God, Smith, I jes wish you could see that coon dog."

Many times in my travels I have met men, who, under more favorable circumstances, might have graced the highest courts in our land or have become masters in the world of commerce and finance. These really great men in many instances were lost to the world through a fine sense of duty to dependent women and children in their little world. As the poet has said "Full many a flower is born to blush unseen and waste its sweetness on the desert air" and many acts of devotion in the depths of the mountains are unknown to mankind. Let us hope that they are recorded in the Great Book of Life.

The typical mountaineer of the older school is nearly always logical in his processes of reasoning. He reaches his conclusions without mental finessing and has a why for every wherefore. I recall passing a camp-meeting ground in the early morning and afterwards passing scores of men and women hurrying to the services. It seemed to me that every house on the mountain would be deserted and that therefore the dinner might have to be abandoned; but a little before noon we heard an old-fashioned flail resounding from the barn, and knew the owner would soon eat and perhaps we might be able to join him. While the meal was progressing I asked my host how it happened that he was not at church. "Well," he said, "I ain't there fer two mighty

good reasons. In the first place I have been using my stock purty consid'ble this season and I ain't had no time fer to corn cob 'em down and get 'em fittin' fu' swappin'; and in the next place I was born and raised in this here county and I know there ain't enough religion among the perfessin' Christians fer to save one soul and I don't perpose to go down to that air meetin' and git my chances of heaven mixed up with them doggone perfessin' Christians."

There was a fine seam of coal, 6 feet in thickness, showing in the outcrop by the barn, but wood only was burned in the house. This fact, however, was easily explained: "Bein' a man of sense and judgment as I 'low ye are, you can see for yourself that that coal is too durn fur fer me to go pack it and it ain't fur enough to hook up a team and go haul it—so we jes burn wood." In justice to his wife it is only fair to remark that she handled an axe with great skill.

Down on the Cumberland Plateau, in Tennessee, I stopped at a cabin that was overflowing with children and when we all sat down to supper the table was lined on both sides from wall to wall. Of course a reference was made to the fine large family and the pride the parents must have in this possession, when the old man by way of reply explained everything: "Yes, sir, it's a big family, but it ain't a matter of choice—it's a matter of nee-cessity. Us folks on the mountain hev to hev big fambleys in order fer to git a fair sprinklin' of boys. Ef you have a passel of boys around the house, some of 'em will do a leetle kase they're fond of their maw, some kase they're feard of their paw—and some kase they ain't got no better sense—and 'tween them boys doin' a leetle and me and the old woman here doin' a h— of a site we manages to live."

There is a charm about the mountains that is not equaled by the prairies with their monotonous levels; and I have had days at sea when the entire ocean would have been gladly traded for a single knob in the Alleghanies. There is a wonderful charm in our clear, cold streams; in the hills when tipped with clouds; the drumming of a pheasant; the play of the squirrels; the flight of birds—all these please the eye. But there is another pleasure in store for the lover of the woods. Imagine a long day drawing to its close, twilight deepening into dark. You are traveling a strange trail in a strange land, when the tinkling of a cow bell or the barking of a dog is heard in the distance and presently the sweet aroma of the "frying pan and bacon" floats down the valley. That is a blissful moment. You are nearing a home for the night and a long hour's talk before a big log fire with all the family present and perhaps a few of the neighbors who have stopped on their way from a grist mill. One night like this in the Pine or Cumberland Mountains of Kentucky, I tried to harvest a little information for use on the following day, but every inquiry addressed to the head of the cabin brought a stereotyped reply: "I don't know nuthin' about them things but I allow as I know as much about matermunny"—meaning matrimony—"as any man on the crick." My host was so full of this subject that after supper I naturally asked for particulars, and this was the tale that he told:

"I've been married three times—an' still a livin'—and that's more'n most of my neighbors can say—and eight of my children are livin'—and most of 'em here now."

They were all there, commencing with two grown girls and ending with a baby a year old.

"The very fust time I married I got a woman with lots of sperit. She had the reddest head this side the mountain and one of her eyes was a leetle crossed and she had more temper than me—and I got some. We fit frequent. We sure-ly did—and finally I got to norating round that I was the only man on Kaintuck water's what could live with her. In them days a feller what had lost his last wife lived in that old clearin' next mine and he 'lowed he could live with her at least 6 months and was willin' to bet a crackin' good young steer against a colt I was raisin' that he could. Me and my wife that then was, talked it over and she was agreeable to goin' perviding we could git a devorce—and we done it easy, kase the squire what married us wuzn't one of the bookkeeping kind and we jes tore up the old stificate in the presence of the two Ramsey brothers who was some of her kin. She hitched up with the other feller and I made a run of moonshine and took things sort o' ca'm and easy like fer a spell. Onst in a while I'd go down to the line fence and look over to see how the steer I was goin' to get was comin' on, and then I got to meetin' the other feller who was still a stickin' and had took to watchin' my colt. I seen he was getting powerful interested, as the 6 months was nigh up, and it made no diffunce how many cockle burs that colt wore it looked good to him, and I was gittin' mighty much worrited. He sure was game. The day before the time was up I knowed that somethin' had to be did—and did quick—and I raked up all the green apples and green corn and collicky stuff I ever heerd of and commenced stuffin' that colt—and it took—and before midnight I went after the feller to come and help do some doctorin'. He swore a site and said it would die afore mornin' and he was goin' home—and he went that way—but he never stopped and he never came back—and I druv the steer over into my lot before 'red-top' turned out to git her breakfast!"

The talk was general for a little while, the men said they remembered the affair, and "red top's" two girls remained quiet, apparently taking the adjustment of affairs as perfectly natural. Without any arguing the old man took the floor again.

"Lots of things is wuss and yit sometimes maybe you find 'em wusser—and too much sperrit in a woman ain't so bad as when you got

one what ain't got any—like my second wife. She was com'fble fat when I got her and kep gittin' fatter and fatter and I 'lowed I'd hev to git the guv'mt to help feed her when she up and died rising three hunder pounds in weight. We had to knock down a lean-to off'n the barn to make a box and it took that other feller's steer and one of my own to sled her up on the p'int whar she still is—but I bet she ain't no lazier dead than she was afore it happened."

"I ain't goin' to say nothin' 'bout this little woman here now, kase she's young and spry and I'm getting stiff in the jints and mout have a leetle trouble in gittin' another if she'd run off."

There was neither a lamp nor a candle in the house and the children lighted slivers of pitch pine for illumination. Some of the rich pitch spluttered into the corn bread and gave the latter a flavor that was never known in modern cooking schools—but perhaps it was introduced to prevent the "last chance" wife from following in the Jumbo-like footsteps of No. 2. Our eminent conservationist, Doctor White, would have commended my economy in food consumption—at that time.

Upon innumerable occasions I have been asked about the religion of the people in the mountains, but the question is hard to answer. Earnest men and women are found in every community. The services of preachers are well attended and the only songs one will hear on a long journey are those taken from hymnals. Great consideration is always given to a minister of prominence and the housekeepers, if notified of the coming of a Presiding Elder or Bishop, will spend days in preparing food. Some 5 or 6 years ago I was planning a trip through Eastern Kentucky when the itinerary of a Presiding Elder was made known to me by the enthusiastic brother who had perfected the arrangements. I at once showed appreciation of the skill of this brother by destroying my own plan and accepting the one made for the elder; but to avoid a conflict in dates and over-crowding in small houses, I made the complete circuit 2 days in advance. That was the time I gained in weight at the rate of 16 ounces a day. The elder lost about 20 pounds on his trip, which is hard to account for, as I had found the living conditions unusually good.

But I must sand the track, sprag the cars, and stop the train. It would please me to tell you about the amateur geologist over in Buchanan County, Virgina, who accounted for an immense mass of broken stone on a slope of the mountain by declaring that he had "studied about it a site and finally 'lowed that when the Lord was in these here parts sowin' rocks, he must have drapped his apron string a-comin' over the pint."

The neighborliness of the people could be exemplified by the attitude of a good old friend in a southern county. He was divorced and at once married again, and the divorced wife immediately married and went to live on the adjoining place. When my host was asked how he got along with his ex-wife he said: "Fine, mighty fine. We are the very best of neighbors. Why, there ain't a family on the mounting we borrow as much from as we do from them folks."

At the risk of being called a bad neighbor, I will cease borrowing from your time and will now turn the Institute into its accustomed channels, at the same time hoping that your stay in Charleston may be pleasant, that old time friendships may be renewed and that your deliberations may result in great good for the thousands of men whose welfare and safety rest so largely in your hands.

From the annual average output of coal per man in the various states can be deduced the relative prosperity of the industry in those states. In 1912, the tonnage per man employed was as follows for the various states: Alabama, 712; Colorado, 844; Illinois, 767; Indiana, 706; Kansas, 600; Maryland, 898; Missouri, 447; Montana, 886; New Mexico, 900; Ohio, 758; Oklahoma, 418; Pennsylvania, anthracite, 485; Pennsylvania, bituminous, 980; Tennessee, 628; Texas, 424; Utah, 906; Virginia, 904; West Virginia, 979.

Miners' Phthisis

In the course of an informal discussion upon rock drills, H. M. Chance spoke of the troubles from fine dust entailed by the newer forms of such machines, and referred to past investigations on the effect of coal dust upon the health of miners, published by the Second Pennsylvania Geological Survey about 1882.

He stated that the fine dust resulting from mining operations, and from industrial pursuits, seemed to affect the lungs and air passages in three ways: (1) When the rock is chiefly of quartz, or silicious material, the dust consists of angular particles or splinters with sharp cutting edges, which particles work through the mucous membrane into the lung tissue, causing serious lesions or death. Such conditions exist in the South African gold mines, and in some of the mines in the western United States, wherever the mineralized rock consists largely of quartz. (2) Other entirely distinct pulmonary and bronchial diseases may be caused by dust or soot which carries irritating or poisonous acids or oils condensed upon the surface of the particles. These substances, while not necessarily fatal in their effects, are likely to render the individual more liable to contract tuberculosis, or other disease, by weakening the tone of the tissues. (3) Another effect caused by the inhalation of large quantities of dust is the overloading of the lungs with foreign material, which, while it may be entirely free from any irritating quality, clogs and finally fills the air cells until they can no longer perform their functions. Coal dust in itself is not particularly dangerous to ordinarily robust men.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Haulage Problem

Editor The Colliery Engineer:

Sir:—In the haulage problem presented by "Mining Engineer," in the February issue, I find in the March issue where "Subscriber" states the following plan: Use Nos. 1 and 2 rooms on the butt entry for partings, for efficient work in electric gathering. This may be secured without any expense or weakening of pillars. We would like to have "Subscriber" send us a diagram showing how this operation is accomplished.

Gus Beaver

San Toy, Ohio

Gases and Ventilation

Editor The Colliery Engineer:

Sir:—(*a*) What effect does a sudden fall of barometric pressure have on the volume of air and gases in mine workings according to Mariotte's law? (*b*) Assuming that the abandoned workings in a certain mine have a total volume of air space of 7,000,000 cubic feet and that the air in this space contains 10 per cent. of marsh gas, how would the air-current in the entry skirting the old workings be affected if the barometer should fall suddenly from 29.55 to 28.74 inches in 9 hours? (*c*) Supposing that this air-current is 10,000 cubic feet per minute and carries normally 2 per cent. of gas, what would be the percentage of gas in the current during the barometric fall, and would this change be detected readily in a safety lamp?

C. T. A.

(*a*) Mariotte's law states that the volume of air or gas varies inversely as the absolute pressure it supports. Then with a decrease of pressure, the volume of air and gas in the mine workings increases.

(*b*) When the barometer drops from 29.55 inches to 28.74 inches, the volume becomes:

$\frac{29.55}{28.74} \times 7{,}000{,}000 = 7{,}200{,}000$ (approximately), or an increase of $\frac{200{,}000}{9 \times 60} = 3{,}710$ cubic feet per minute.

(*c*) If the 3,710 cubic feet of additional air and gas contained 10 per cent. gas there was 371 cubic feet of marsh gas present; 10,000 cubic feet have a 2-per-cent. content or 200 cubic feet.

The ventilation during the fall then is 13,710 cubic feet per minute, of which 571 cubic feet is marsh gas or 4.16 per cent., an amount which can be readily detected by means of a safety lamp.

Editor

Information Wanted

Editor The Colliery Engineer:

Sir:—We are endeavoring to locate the parents of Peter Martin, who was killed here in an accident on March 31.

In his declaration for employment, Martin stated he was a single man and that his parents lived in Lithuania. He also stated that he had worked in the Pennsylvania coal mines for 7 years. He was 26 years of age; height, 5 feet 9 inches; weight, 155 pounds; brown hair; blue eyes. His name was evidently an assumed one; it may have been Martinski. So far as we can learn, he had no relatives in this country. He left a bankbook showing a deposit to his credit of about $300.

Should this come to the attention of any one who has information concerning Martin or his parents, they are requested to communicate with the undersigned.

D. S. Hanley, Gen. Mgr.,
Carbon Coal and Clay Co.,
Bayne, Wash.

Qualifications for Certificate in Alberta

Editor The Colliery Engineer:

Sir:—The Miners Act, that was enacted, came into operation in August, 1913, in the Province of Alberta, reads as follows:

"The chief inspector may sign and deliver a certificate to an applicant without examination, who is the holder of a certificate in this or any other country, if this Board of Examiners think that the standard of training and examination for such certificate is equivalent to the standard of training and examination required for a certificate under this Act."

A number of us have made application to the Board of Examiners in compliance with this clause, and I want to know if the standard of training and examination in Great Britain is below that of the Province of Alberta today. From my knowledge the allotment of marks is more in Alberta; correspondingly the questions are more in number and I believe the time limit is more in Alberta. I wish to have some information from any person better informed than I am on this question.

Andrew Barclay

Bankhead, Alta., Canada.

Method of Mining Wanted

Editor The Colliery Engineer:

Sir:—I would be obliged to any of your readers who would give me advice on a good way to work the following seam of coal and what tonnage could be expected from each working place: The seam is 7 feet thick and is opened by a slope which dips 30 degrees at the top and 18 degrees at a depth of 1,600 feet. The airways and manways are driven parallel, with 60-foot pillars between them. There is another coal bed 75 feet above the one being

worked and still another 60 feet below, with comparatively hard rock between them. A section of the seam from the floor up, gives: hard dirt, 8 to 10 inches; coal, 3 feet; hard rock, 8 to 10 inches; coal, 2 feet 6 inches.

The method adopted in airways and breakthroughs is first to mine the bottom dirt bench and gob it, then blast the bottom coal, after which the middle rock is taken down and gobbed; and lastly the top coal is broken down. This gives good coal, but the tonnage per working face has been unsatisfactory.

GEO. RANKIN

Georgetown, Canmore, Alta.

Destruction in Mexico

Mr. F. E. Mueller, contract manager of the Roberts and Schaeffer Co., of Chicago, Ill., sends further information regarding the destruction of surface arrangements at coal mines in Mexico, mention of which was made in the October, 1913, issue, of THE COLLIERY ENGINEER. The Sabinas coal field in the northeastern part of the state of Coahuila is the best coal field so far discovered in Mexico, and in it are several large operations. The Agujita and Lampacitos mines in this field belong to the Compania Carbonifera Agujita y Anexas, and were destroyed because it is said that they furnished aid to the Federals. The condition of the Lampacitos washery after the Carransistas had gotten through with it August 16, 1913, is shown in Fig. 3. Two hundred houses at this place were destroyed, some of which are shown in Fig. 2 to be of brick and constructed to conform with the heat conditions which prevail in Mexico.

FIG. 1. REMAINS OF AGUJITA NO. 2 TIPPLE

On September 27, 1913, the Agujita surface plant was destroyed and although the loss was not so great as at Lampacitos, it was enough to put the mine out of business. In Fig. 1 is shown the remains of the Agujita No. 2 tipple, which was destroyed together with washery, warehouse, fans, power house, general office, and 70 other buildings.

In this field there is a thin draw slate about ⅛ inch thick which breaks with the coal and becomes mixed with it. As the fine coal is coked, the Roberts and Schaeffer Co. constructed a large and successful washery for separating the coal from the draw slate. In case this flat slate is not separated it weakens the structure of the coke, besides adding impurities.

The Mexican International Railroad was also badly wrecked for a distance of 200 miles south.

Mining Education

In discussing the changing situation in regard to mining technology experts say that while formerly mining engineers went to Freiberg, Saxony, to put the finishing touches on their curriculum, now the conditions are reversed and Europeans and other nationalities come to American mining schools.

FIG. 2. REMAINS OF HOUSES AT LAMPACITOS

FIG. 3. REMAINS OF LAMPACITOS WASHERY

Answers to Examination Questions

Questions Asked at an Examination for Mine Foreman, Held at Sheridan, Wyoming, 1914

Ques. 5.—Name the gases met with in coal mines, giving their symbols and specific gravity.

Ans.—The gases found in mines may, so far as their origin is concerned, be divided into two general groups as follows: The gases always present in the air and commonly known as atmospheric gases, and those gases which, while sometimes found in the outside air, are usually due to mining operations and are, therefore, generally and more properly called mine gases.

The atmospheric gases are oxygen, symbol O, specific gravity, 1.1055; and nitrogen, symbol N, specific gravity, .9701. To these may be added vapor of water, or moisture, with the symbol H_2O.

The mine gases are carbon dioxide (small amounts of which are always present in the outside air) the symbol of which is CO_2 and which has a specific gravity of 1.5201; carbon monoxide, symbol CO, specific gravity, .9673; methane, symbol CH_4, specific gravity, .5539; and hydrogen sulphide, symbol H_2S, specific gravity, 1.1773. In rare instances there may be found in mine air very small amounts of sulphur dioxide, symbol SO_2, specific gravity, 2.2131; ethane, symbol C_2H_6, specific gravity, 1.0381, and ethylene, symbol C_2H_4, specific gravity, .9784.

Ques. 6.—Explain spontaneous combustion of coal and its attendant dangers.

Ans.—Spontaneous combustion is the ignition of coal without the direct application of flame and is due to the absorption of oxygen from the air by fine coal or slack. In reality it is ordinary burning or combustion, but begins very slowly and without flames, this last phenomena of combustion as ordinarily understood not appearing for some time, if at all, the pile of coal or slack merely smouldering.

The danger from spontaneous combustion is twofold. During the process, volumes of poisonous gases are given off, and these, carbon dioxide and more particularly carbon monoxide, are injurious to health and may prove fatal and, further, the latter is explosive. Also, there is the possibility and even the high probability, that the fine coal will break into flame and thus start an extensive and serious fire in the workings.

Ques. 7.—A fire breaks out from the old workings on the intake side a thousand feet from the drift mouth. The fan is exhausting. (*a*) What will you do if the mine generates firedamp? (*b*) What if it is non-gaseous? (*c*) Is there any danger of an explosion in the latter case? If so, explain how.

Ans.—In any case of fire get the men out of the mine at once. It may be assumed that the fire has gathered no great headway. In this case it is probable that it may be put out by the application of water, sand, or fine clay, or at least so smothered that the smouldering material may be loaded into cars and hauled from the mine. If this is not efficacious and the fire is in such a place or in such material that it cannot be put out by the means at hand, it may be necessary to seal off a portion of the workings so that the products of combustion will in time smother the flames. If the fire is confined to one room only, its mouth and the breakthroughs to the neighboring rooms must be closed with air-tight stoppings, after which the fire is permitted to burn itself out. If the fire covers a more extended area, a whole section of the mine may have to be walled off with masonry. The stoppings first built are of wood, and behind these are constructed the more permanent ones of brick, masonry, or concrete. It is a disputed question whether the stoppings on the intake or return side of the fire should be built first. Unless local conditions are against, it would seem better practice to begin all the stoppings at the same time and to build them up with equal speed.

Opinions differ as to the handling of the fan during the progress of a fire. At first glance and without consideration it would appear that the fan should be either shut down or turned very slowly in order to diminish the air supply and thus to help smother the flames by cutting off the oxygen. On the other hand, if the mine generates gas, this will accumulate sufficiently to explode if the air-current is reduced much below the usual amount. Also, whether the mine generates gas or not, the cutting down of the air supply will cause some, at least, of the carbon to burn to carbon monoxide, which is both explosive and poisonous.

In a non-gaseous mine in which a fire is burning an explosion is possible from one of two causes. One is the explosion of the carbon monoxide formed by the burning coal in a deficient air supply as just ex-

plained, and the other would be the throwing of large volumes of fine dust into the fire by, say, the jar produced in the air-current when suddenly short-circuited by the burning down of a brattice near or at the fire, thus originating a so-called dust explosion.

Ques. 8.—Having two airways, 5 ft. × 7 ft. and 5 ft. × 9 ft., respectively, which would you use for a return, and why?

Ans.—The larger, the 5 ft. × 9 ft., should be used as the return, for the reason that the air leaving the mine usually has a larger volume than when it enters. The volume of the outgoing air is increased, partly by the addition of the gases given off by the coal, blasting, etc., but more especially is its volume increased by the expansion due to the underground or mine temperature being greater than that at or on the surface. The mean annual temperature is about 52° F., and this is, of course, the mean or average temperature of the air entering the mine. The average underground temperature is not a matter of record, but is probably not far from 65° F. That is, the mean absolute temperature of the intake air is 460 + 52 = 512°, and of the outgoing air 460 + 65 = 525°, and the volume of the latter is greater in the ratio of 525 : 512.

Ques. 9.—(*a*) What is a safety lamp and how is it constructed? (*b*) What make do you consider the best? (*c*) How many apertures in a square inch of the gauze?

Ans.—(*a*) A safety lamp is a lamp of special construction designed to give a light when used in air contaminated with explosive gases, and without igniting the same. The term safety is not quite the correct one, as cases arise where no lamp burning oil or other fluid can be used, and further, the lamp itself, being liable to disarrangements in its parts, may become a source of danger. The lamp is safe when in good order and when used with care under those conditions that experience has shown to be proper for its use.

The safety lamp consists of a metal chamber to contain oil, naphtha, etc., and a wick for burning it. Surrounding the flame is a glass cylinder to permit the passage of the light of the burning oil, and above this is a fine metal gauze through the pores of which the air necessary for combustion enters and also through which the products of combustion escape. The lamp is commonly provided with a so-called magnetic lock to prevent it being opened by an unauthorized person, a relighting device, etc.

Assuming the lamp to be held in a place where there is enough methane present to be ignited by the flame, the gas will, of course, burn within the lamp, but the products of combustion will be so cooled by passing through the minute holes in the metal gauze that their temperature will be too low to ignite the methane outside the lamp.

(*b*) The choice of lamp, from the nature of the question, depends upon the preferences of the individual. Judging from the number in use, the Wolfe lamp, burning gasoline or naphtha, is a universal favorite.

(*c*) Safety-lamp gauze is commonly what is known as 28 mesh; that is, it has 28 openings in each linear inch or 28 × 28 = 784 openings in each square inch.

Ques. 10.—What is afterdamp, and what is its composition after an explosion in a large quantity of air, and after an explosion in a small quantity of air?

Ans.—Afterdamp is the air remaining in a mine after an explosion of methane or coal dust, or both. It consists of the nitrogen originally in the air, as much (if any) of the oxygen as is not needed to burn the methane or coal dust, and the products of combustion resulting from the explosion, which are vapor of water and carbon dioxide or carbon monoxide or both.

When methane burns in just the right amount of air, the reaction is

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

Since all the oxygen in the air is consumed in burning the methane, the afterdamp will consist of nitrogen, carbon dioxide, and vapor of water. Usually, however, there is much more air present than is needed to furnish oxygen for burning the methane, so that the afterdamp almost always contains more or less oxygen.

Authorities differ as to just the reaction that takes place when methane is burned in not enough air for its complete combustion. By some it is claimed that, under these conditions, only as much methane is burned as there is oxygen present to form carbon dioxide, the excess of methane being unburned and remaining in the afterdamp as such. Others assert that the reaction taking place is

$$2CH_4 + 3O_2 = 2CO + 4H_2O$$

If this last reaction holds good, all the oxygen in the air would be consumed and the afterdamp would be the same as before, with the substitution of carbon monoxide for carbon dioxide.

In all extensive explosions the carbon monoxide in the afterdamp is due to the imperfect combustion of the carbon in the coal dust.

Ques. 11.—How may the greatest security be obtained when danger from firedamp exists?

Ans.—To reduce the danger from possible firedamp explosions, the amount of methane in the mine air must be kept below the explosive limit of this gas. Modern practice requires, particularly where the coal dust is explosive, that the proportion of methane in the return air-current shall be less than 1 per cent. To reduce the proportion of methane to this small amount, the air supply must be ample, requiring the use of a fan of good capacity. In addition the airways should be as large and straight as is economically possible, and they should be kept clean and free from falls. Further, the air should be divided into splits instead of being conducted in a continuous current throughout the mine, means should be taken to carry the air to the face where needed by means of

brattices, and all stoppings, brattices, etc., should be made air-tight.

Ques. 12.—How would you proceed to enter a place supposed to contain firedamp, and where would you hold the lamp to find it?

Ans.—Unless extremely gaseous, it is customary at some mines for the fireboss to carry an open light in addition to the safety lamp, at least while traveling along the main entries. This, however, is always bad practice and positively forbidden by most coal companies. This open light, in some mines, may safely be carried up a room or out the entry to the last open breakthrough, but never should be taken beyond this point. It is better practice not to use an open light, but instead to use one of the modern portable electric storage battery lamps, either of the hand or hat type. These give a most excellent light for traveling and may be carried to the face in the most gaseous mines.

In testing for gas, some fire bosses prefer to use the flame of the safety lamp at its usual or nearly at its usual height, but the majority draw the wick down until only a very small flame is visible. In the process of testing, the lamp is held vertically with the hand behind the flame to screen it, and is raised slowly toward the roof while a watch is kept for the appearance of the pale blue cap which indicates the existence of gas.

Ques. 13.—If an explosion occurred in your lamp, what would you do?

Ans.—When an explosion occurs inside a safety lamp, no quick movement should be made, as this may force the flame through the gauze and thus ignite the body of firedamp in the place. While the lamp, under these conditions, must be immediately removed, the removal must be made with extreme caution by bringing it slowly toward the floor.

Ques. 14.—What is coal dust? State the possible dangers from blasting when it is present. What would you do to avoid such dangers?

Ans.—Coal dust is finely powdered coal, commonly in such fine flour-like particles that it is easily carried along by the air-current. Usually those particles that are small enough to pass through a 20-mesh (400 openings to the square inch) sieve, are called dust.

The danger of blasting in the presence of dust arises from the fact that the heat generated by a blown-out or windy shot, is often sufficient to set this dust on fire. As the ignition of the dust is instantaneous, its burning is really an explosion, which is communicated from particle to particle, usually sweeping entirely throughout the mine, as dust is universally present underground. All the large mine explosions have been coal-dust explosions, very many of which have been started by the ignition of coal dust at the mouth of a poorly placed or overcharged shot hole.

To reduce the danger of coal-dust explosions to a minimum, not only must means be devised to prevent the ignition of the dust, but the formation of dust must also be prevented. The formation of dust may be reduced by undercutting the coal with machinery and bringing it down with the smallest amount of permissible powder in well-balanced holes. Fine coal should be loaded out in tight cars; in fact, all mine cars should be free from open cracks through which fine coal may drop out upon the roadbed, and the cars should not be loaded so full that any part of their burden will fall off upon the track, there to be ground into dust by the feet of passing men and mules.

In addition to the above precautions, most of which serve as well to reduce the danger of igniting the dust as to prevent its formation, particular care should be taken before shooting to see that the place is cleaned up and is free from dust. It is highly advisable that some means be adopted to render the dust at the face inert and non-explosive. This may be accomplished by thoroughly watering the roof, floor, and ribs for a distance of 50 to 80 feet back from the face, or by the application of finely powdered clay, shale, or adobe. Finally, coal dust should never be used for tamping, only clay or adobe, and shots should be fired by electricity, after their location, charging, etc., have been inspected and approved by a competent shot firer.

Ques. 15.—If the ventilation was insufficient and you could not increase the power, how would you increase the amount of air in circulation?

Ans.—The only way the quantity of air may be increased without directly increasing the power is to reduce the resistance or friction in the airways. By so doing a larger proportion of the power is rendered available for moving a larger volume of air.

The friction may be decreased by cleaning up the airways, thereby increasing their area; by straightening them if possible, thereby reducing the distance the air has to travel; and in some instances it may be financially possible to gain increased height and consequently greater area by shooting down the roof slate. In order that ample air may be carried to the face, the breakthroughs should be of the same size as the airways, and all brattices should be made air-tight to prevent leakage. Finally, the air instead of being carried through the mine in a continuous current, should be divided into two or more splits, as this splitting of the air-current has the same effect as increasing the area of the airways.

Ques. 16.—What, in your opinion, is the best method of reducing friction in airways?

Ans.—In order to reduce the friction in airways, they should be made as large, as straight, and as smooth as possible, and they should be kept free from falls of slate and accumulations of rubbish. It is not always possible to make the entries straight or large or smooth, as the expense thereof may be excessive or the character of the coal or general mining conditions may make it impossi-

ble, but it is always possible to keep them clean.

Ques. 17.—Which should be the larger, if either, the main intake or the return, and why?

Ans.—The return airway should be larger because (*a*) the volume of the return air is greater than that of the intake by that of the gases given off by the coal, by blasting, etc., because (*b*) the volume of the return air is greater than that of the intake due to its expansion in the generally greater underground temperature, as explained in Ques. 8, and because (*c*) owing to the resistance of the mine to the passage of the air, the return current is under slightly less pressure than is the intake, and is, consequently, slightly greater in volume.

Ques. 18.—What is meant by splitting the air volume, and what are its advantages?

Ans.—Instead of conducting the air in one unbroken current through the mine, it is a common practice to divide it into two or more separate currents called splits, either at the foot of the shaft or at some point or points inside the workings.

The advantages of splitting the air are: (*a*) The velocity of the air for the same volume in circulation is materially reduced, which is of value in comparison with the very high velocities sometimes found in gaseous workings. (*b*) For the same power a larger volume of air may be kept in motion. (*c*) The air at the face is purer, since each district is supplied by its own split directly connected to the main intake, and the foul air passes at once to the main return instead of being conducted along the entire working face as is the case when the continuous system of ventilation is used. (*d*) The ventilation is more easily controlled and the supply of air to any district may, within quite wide limits, be increased or decreased as needed. (*e*) As the districts or splits are independent, the effect of an explosion in any one district is less apt to be carried over to any of the others.

Ques. 19.—How would you ascertain the quantity of air circulating in a mine?

Ans.—The total quantity of air in cubic feet circulating per minute in a mine is found by multiplying the area of the return airway in square feet by the velocity of the air in feet per minute, that is,

Quantity = area × velocity

The area is usually measured in some part of the return where the dimensions are judged to be average ones, and measurements are expressed in feet and decimal parts thereof.

The velocity is measured by an instrument known as an anemometer, the number of revolutions of which per minute, when held in a current of air, equals the velocity of the air in feet per minute.

THE PRIZE CONTEST

It has been decided to discontinue the Prize Contest department. The following are answers to the questions published in March.—EDITOR.

Answers for Which Prizes Have Been Awarded

Ques. 58.—State what factors determine the size of a hoisting shaft for a coal mine. What size would you adopt for working a coal seam lying 300 feet below the surface, the seam is 6 feet thick with good roof and bottom? Assume the mine output per day to be 1,200 tons in 10 hours.

Ans.—The principal factors governing the size of a hoisting shaft are: Depth of the shaft; output speed; tonnage, expressed in tons or pounds; number of working hours; thickness of the coal seam; weight of a cubic foot of broken coal; clearance in the shaft at the ends of the cage; clearance between the sides of the car and the cage; average inside width of car; average inside length of car; average inside depth of car; the area of workable coal in the property; and condition of roof and floor, as they sometimes determine the width of mine car.

Assume for this case that all delays at the shaft bottom, such as waiting on coal and hoisting men, are eliminated; in practical mining, such delays occupy from 5 to 20 per cent. of the actual working hours, depending upon the management, arrangement of shaft bottom, length and system of haulage.

As the area of workable coal in the property largely determines how such money shall be invested in shaft and plant, I will assume first that the workable coal in this property will be exhausted in 1½ years, therefore I would construct the cheapest shaft possible, which in this case would be a single-compartment shaft.

$$\text{Tonnage per hour} = \frac{1,200}{10} = 120 \text{ tons}$$

Cars per hour, using a 2½-ton capacity car $= \frac{120}{2.5} = 48$ cars, or one car every 1¼ minutes. By using a second-motion engine, with a hoisting speed of 900 feet per minute, ample time is given for changing cars on the cage.

The size of the mine car is calculated, by assuming that 1 cubic foot of broken coal weighs 50 pounds. Therefore, the car will have a capacity of 5,000 ÷ 50 = 100 cubic feet. Fig. 1 is a sketch of the size of car, cage, and shaft.

Since the cross-section of the car is 11.2 square feet, the length of the car inside equals 100 ÷ 11.2 = 8.92 feet or 8 feet 11 inches. The total

length of the car then will be (length inside) + (thickness of boards and irons at each end) + (the length of bumpers). Substituting these values, 8′ 11″ + 4″

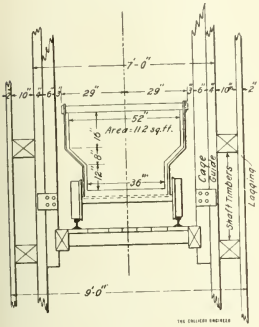


Fig. 1

+ 12″ = 10′ 3″, the total length of the car. Allowing one-half foot as clearance at each end of the mine car, the length of the shaft inside the timber will be 10 feet 3 inches + 1 foot = 11 feet 3 inches. Therefore the size of the shaft is 7 feet × 11 feet 3 inches, inside of the timbers, or 9 feet × 13 feet 3 inches, outside of the lagging.

Second. Assuming all of the conditions are the same as above, excepting that the workable coal in the property will not be exhausted for two or more years.

In this case I would use a two-compartment shaft, single-deck cages, hoisting in balance. Cars per hour, using a 1½-ton capacity car $= \frac{120}{1.5} = 80$ cars per hour, or one car every 45 seconds. By using an engine with a hoisting speed of 600 feet per minute, ample time will be allowed for changing cars on the cages.

The mine car will have a capacity of 3,000 pounds ÷ 50 pounds = 60 cubic feet. The car should be of sufficient length to accommodate the mine timber, or say 6 feet 2 inches long inside. Hence, the total length of the car equals: (length inside) + (thickness of boards and irons at each end) + (the length of bumpers at each end). Substituting these values: 6′ 1″ + 4″ + 12″ = 7 feet 5 inches. Allowing a clearance of 6½ inches between the end of car bumpers and the shaft timbers, the length of the shaft = 7 feet 5 inches + 1 foot 1 inch = 8 feet 6 inches, inside of timbers, or 8 feet 6 inches + 10 inches + 2 inches + 10 inches + 2 inches = 10 feet 6 inches outside of lagging.

The mine car must have a cross-section of $\frac{60}{6.08} = 9.87$ square feet.

This can be obtained in a car of the same width and size as that shown in Fig. 1, with the exception of the depth of the top board which is shown as 16 inches deep, but in this case it will be only 12⅜ inches deep. Therefore, the compartments in this shaft are of the same width as the single-compartment shaft.

David H. Abram
1004 Horner St., Johnstown, Pa.

Ques. 59.—Describe the manner of setting a valve of an engine. State, also, in what case you would use an early cut-off, and give sketch showing the position of the valve at the time of cut-off on the following stroke of the engine.

Ans.—We will first place the engine on the dead center, and will simply explain the other steps that have to be taken.

In the first place, it should be understood what result is obtained by adjusting the position of the eccentric and the length of the valve stem. The position of the eccentric when the valve is set, depends upon which way the engine is to run and whether the valve is connected directly to the eccentric or whether it receives its motion through a rocker which reverses the motion of the eccentric.

When the valve is direct-connected, the eccentric will be ahead of the crank by an amount equal to 90 degrees, plus a small angle called the angular advance. When a reversing rocker is used, the eccentric will be diametrically opposite this position, or it will have to be moved around 180 degrees and will follow, instead of lead the crank. Shifting the eccentric ahead has the effect of making all the events of the stroke come earlier, and moving it backwards has the effect of retarding all the events.

Lengthening or shortening the valve-stem cannot hasten or retard the action of the valve, and its only effect is to make the lead or cut-off, as the case may be, greater on one end than the other. The general practice is to set a slide valve so it will have equal lead.

To set the valves, therefore, put the engine on the center, remove the steam-chest cover, and adjust the eccentric to about the right position to make the engine turn in the direction desired. Now make the length of the valve spindle such that the valve will have the requisite amount of lead, say 1/16 of an inch, the amount, however, depending upon the size and speed of the engine. Turn the engine over to the other center, and measure the lead at the end. If the lead does not measure the same as before, correct half the difference by changing the length of the valve stem and half by shifting the eccentric.

Suppose, for example, that the lead on the head end proved to be too much by half an inch. Lengthening the valve stem by half of this, or ¼ inch, would still leave the lead ¼ inch too much on the crank end. That is to say, the valve would then

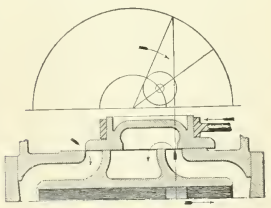


Fig. 2

open too soon at both head and crank ends, and to correct this, the eccentric would have to be moved back far enough to take up the other ¼ inch.

Sometimes it is not convenient to turn the engine over by hand, in which case the valve may be set for equal lead as follows: To obtain the correct length of the valve stem, loosen the eccentric and turn it into each extreme position, measuring the total amount that the valve is open to the steam ports in each case. Make the port opening equal for each end by changing the length of the valve stem. This process will make the valve-stem length as it should be. Now put the engine on a center and move the eccentric around until the valve has the correct lead and fasten the eccentric in that position. This will determine the angular advance of the eccentric.

An early cut-off on a plain slide-valve engine necessitates an early compression, which becomes excessive when the cut-off takes place before about ⅔ stroke. Hence, a plain slide valve is seldom arranged to cut-off earlier than ⅔ or ¾ stroke, except in case of high-speed engines and locomotives where the compression is not so objectionable and, indeed, is often an advantage. All who have had experience setting slide valves are aware, in a general way, that the events of the stroke cannot be independently adjusted; such as a cut-off earlier than about ⅝ of the stroke. Fig. 2 is a diagram of a slide valve cutting off at ⅝ stroke.

Charles R. Drum

California, Pa.

Ques. 60.—A shaft on a hill is 150 feet deep and is making 4,000 gallons of water per hour. Near the mouth of the shaft is a ravine descending to a river 100 feet below the level of the shaft bottom. How would you handle this drainage?

Ans.—A tunnel or (adit level) could be driven from the hillside to the bottom of the shaft with sufficient rise to allow the water to gravitate from the shaft to the hillside; or a borehole could be drilled from the hillside with sufficient rise to allow the water to gravitate from the shaft to the hillside.

Local conditions would help to decide which system could be adopted; I prefer a small tunnel driven on a rise of 1 per cent. This tunnel should be about 3 feet square with a small ditch to keep the water flowing on one side of the tunnel only. As the tunnel would not be of great length and would be a permanent drainage road, I should brick the sides, floor, and also brick arch the roof so that the flow of water would not be impeded by small caves from the side and roof.

In the borehole method a pipe could be run from the shaft to the hillside, thus allowing a good passage for the flow of water providing the pipe is large enough; but with pipe drainage there is possibility of pipe becoming choked up from the dirt and obstacles that are carried in the water. A wire-netting cover should be put over the intake end of the pipe to prevent this.

With the ditch system cut along the bottom of the tunnel, any obstacles in the ditch could be cleaned out without loss of time or much trouble, therefore, I prefer the tunnel system of drainage.

A pump could be placed on bottom of shaft to deal with the water but it would be unwise to use mechanical power when gravity can be taken advantage of.

Dr. Moses Johnson

Tabor, Alberta

Ques. 61.—Determine the efficiency of a pump that is discharging 1,200 gallons of water per minute, under a vertical head of 250 feet, at an expenditure of 125 horsepower. What should be the diameter of the discharge and suction pipes of this pump?

Ans.—The theoretical horsepower required to raise water is found by the formula

$$\text{H. P.} = \frac{G\,p}{1{,}714.5}$$

in which

G = United States gallons discharged per minute;

p = pressure in pounds per square inch or .433 (height of lift in feet).

Substituting the given values in the above formula, the theoretical horsepower required to discharge 1,200 gallons of water per minute under a vertical head of 250 feet is

$$\text{H. P.} = \frac{1{,}200 \times .433 \times 250}{1{,}714.5} = 75.765$$

If the actual horsepower expended is 125, the efficiency of the pump would be the ratio existing between the theoretical horsepower required and the actual horsepower expended or $\frac{75.765}{125}$ or 60.6 per cent.

It has been shown by experience that for satisfactory work the flow of water in the suction pipes of pumps should not exceed 200 feet per minute and it should not be more than 400 feet per minute in the discharge pipe for a single-cylinder double-acting pump.

Assuming that these maximum velocities are maintained in the suction and discharge pipes, the diameter of the discharge pipe is found by the following formula:

$$d'' = 4.95\sqrt{\frac{G}{v''}}$$

in which

d'' = diameter of the discharge pipe in inches;

G = United States gallons of water discharged per minute;

v'' = velocity of water in feet per minute in the discharge pipe.

Substituting the given values in the above formula

$$d'' = 4.95\sqrt{\frac{1{,}200}{400}} \text{ or } 8.57 \text{ inches.}$$

The diameter of the suction pipe is found by the following formula:

$$d' = 4.95\sqrt{\frac{G}{v'}}$$

in which

d' = the diameter of suction pipe in inches;

G = United States gallons per minute;

v' = velocity of water in feet per minute in the suction pipe.

Substituting the given values in the above formula

$$d' = 4.95\sqrt{\frac{1{,}200}{200}} \text{ or } 12.12 \text{ inches.}$$

The diameters of the suction and

discharge pipes may also be found by substituting in the formula

$$A = \frac{144\,V}{v}$$

in which

A = area of pipe in square inches;
V = volume to be discharged per minute;
v = allowable velocity.

The volume of one gallon of water being .13368 cubic foot, that of 1,200 gallons of water will be 160.416 cubic feet.

Substituting in the above formula, to find the area of the discharge pipe

$$A = \frac{144 \times 160.416}{400} = 57.75 \text{ sq. in.}$$

The diameter of a circle may be found by dividing the area by .7854 and extracting the square root, which would make the diameter of the discharge pipe 8.57 inches.

Substituting to find the area of the suction pipe

$$A = \frac{144 \times 160.416}{200} \text{ or } 147.06 \text{ sq. in.}$$

The diameter of the suction pipe is found by dividing the area by .7854 and extracting the square root = 12.12 inches.

This checks the previous result. However, the nearest standard nominal sizes of pipe to be used would be 12-inch diameter for the suction and 9-inch diameter for the discharge pipes.

C. H. Beidenmiller

Nanticoke, Pa.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Emery's Miners' Manual.—We have received the second edition of the Emery's Miners' Manual. It is written by George D. Emery, Esq. This is a handbook on the law of mines and mining with necessary forms for prospectors, lawyers, surveyors, mine owners, engineers, and mining companies. It includes the laws of Alaska and the regulations of the United States Land Office, Rules to practice before land office, etc., the laws of British Columbia and Yukon, coal land laws of the United States, British Columbia, and Alaska, with full forms and instructions for locating, representing and patenting coal land and mining claims. It also contains a glossary and table of cases. The book is published by Callaghan & Co., 401 East Ohio Street, Chicago, Ill. Price $3.50. The reviewer thinks that this book should be in the hands of all those interested in mining in any way, particularly those engaged in mining in the western part of the United States and British Columbia, as it is a clear, concise, easily understood rule book to be used in all matters pertaining to mines and mining.

The Mining World Index of Current Literature, Vol. IV, July to December, 1913. This fourth volume covers the technical literature published in most countries of the world by the various journals. It also gives a list of the textbooks published on the various technical subjects relating to mining and their prices, for the period it covers. This Index is devoted entirely to mining and metallurgical industries. Part I is indexed for metals, Part II for non-metals, and Part III for Technology. Publishers, Mining World Co., Monadnock Block, Chicago, Ill., U. S. A.

Missouri Bureau of Geology and Mines has issued Vol. 12, Second Series. It treats of the Geology of the Rolla Quadrangle, and is by Wallace Lee. The quadrangle is located in Phelps and Dent counties in the northern part of the Ozark uplift. H. A. Buehler, State Geologist, Rolla, Mo., should be addressed in reference to this book and also to the Biennial Report of the State Geologist which has just appeared. The coal mined in Platt County is hauled under the Missouri River and loaded on cars in Kansas.

George Brown, a hoisting engineer at a gold mine in Roodepoort, South Africa, was lowering a skip with a man in it, when some miscreant threw a dynamite cartridge with a lighted fuse in it on the engine-room floor. Brown shut off the steam, put on the brakes and managed to get outside the door as the bomb exploded. The company as a reward, gave Mr. Brown a check equivalent to $250.

Catalogs Received

National Tube Co., Frick Building, Pittsburg, Pa. Circular, Thought It Was Steel—But It Wasn't; circular, The Shelby Seamless Cold-Drawn Steel Trolley Pole.

J. C. Stine Co., Tyrone, Pa. The J. C. Stine Duplex Pump, 4 pages; J. C. Stine Patented Disc Fans and Machinery, 28 pages.

Merrell Manufacturing Co., Toledo, Ohio. Pipe Threading and Cutting Machinery, 35 pages.

General Electric Co., Schenectady, N. Y. Index to Bulletins, 12 pages.

Waterhouse Welding Co., Boston, Mass. Welding and Cutting Plants, 16 pages.

Draeger Oxygen Apparatus Co., 422 First Ave., Pittsburg, Pa. The Draeger Self-Rescuer, 8 pages.

Bristol Co., Waterbury, Conn. "Bristol" Patent Safety Set Screws, 4 pages.

Wagner Electric Manufacturing Co., St. Louis, Mo. A Manual of Electrical Testing, 48 pages.

Central Foundry Co., 90 West St., New York, N. Y. Valve Service and Roadway Boxes, 21 pages.

Rivetless Chain & Engineering Co., Avon, Pa. Booklet, 20 pages.

Armstrong Cork Co., Pittsburg, Pa. Nonpareil Insulating Brick, 31 pages.

Hess-Bright Manufacturing Co., Front Street and Erie Ave., Philadelphia, Pa. Hess-Bright Ball Bearing Hangers, 16 pages.

Scranton Pump Co., Scranton, Pa. Scranton Duplex Plunger Pumps, 12 pages.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Chicago Coal Drills, 12 pages.

NEW MINING MACHINERY

Safety Application of the Swing-Gate Valve

By Oscar C. Schmidt

One of the most important safety devices to prevent disaster to steam and hydraulic prime motors is the swinging gate and check-valve, which acts as a safety valve wherever it is necessary that the flow of water or steam through a pipe shall be in one direction.

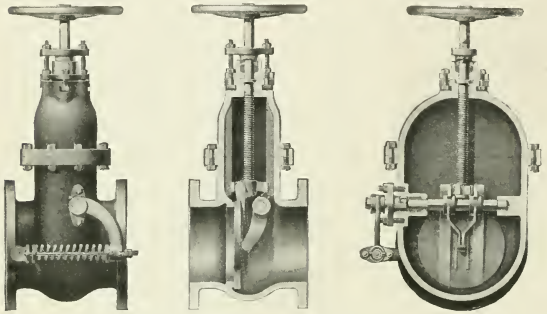


Fig. 1. Nelson-Erwood Swing-Gate Valve

The wide and extensive use of the steam condenser and the boiler feed-water heater has made the connections of pipe lines and valves matters of considerable importance, because great damage can be done if the wrong valve is manipulated at the wrong time, or if the proper valves are not operated when starting and stopping.

It is also often necessary to remove the checking device, and allow an unrestricted flow of the water or steam, which would cause back pressure, or allow sediment to collect, as well as permit the current to be reversed under pressure.

All these advantages of safety and operation are attained by the Nelson-Erwood swing-gate valve, shown in Fig. 1, which is a combined check-valve and gate and capable of performing the functions of either. The action of the swing gate is controlled by a spring, outside of the valve casing, the tension of which is regulated by the pressure desired. The action of the gate valve is controlled by the hand wheel, which raises the gate above the valve opening, thus giving a straightaway opening, with no obstruction in the pipe. The face of the gate and the seat ring are flat, both being made of bronze. The valve gate and seat are cleaned by raising and lowering the gate, which shears off any foreign matter which would otherwise prevent closing.

One of the most interesting applications of the swing-gate valve for safeguarding the usual compound-engine plant is shown in Fig. 2. Not only do these valves permit the operation of either cylinder singly, but they also allow cross-condensing or non-condensing. The swing-gate valve *A* protects the high-pressure cylinder; the swing valve *B* closes the receiver from the atmosphere; the swing-gate valve *C* acts as an automatic relief between the condenser and low-pressure cylinder; the swing gate *D* acts to prevent any water from flowing from the condenser into the low-pressure cylinder. Such an arrangement positively safeguards the engine from any possible action which may be caused by operating conditions or negligence of operation.

The application of this safety principle to a single non-condensing engine is shown in Fig. 3. The engine is always fully protected when swing-gate valve *A* is closed at noon, and swing-gate valve *C* during the night. Swing-gate valve *B* is closed against the atmosphere, and is set for the desired resistance or back pressure. When connected to a heating main *D* the swing-gate valve *C* is set against the pressure regulating valve *E*, and prevents loss of steam through valve *B* in case of regulator not working properly.

In all these various applications to the exhaust lines of steam engines, as well as on the exhaust lines of other steam-driven machinery, the swing-gate valve should be kept closed, as these can be started or stopped by simply opening the steam valve. In this way the exhaust from one engine or pump cannot back up or water-log the cylinder of another, when either running slowly or when stopped entirely. This is important when a number of pumps are connected to the same line, giving freedom from accident under various operating conditions.

The swing-gate valve is also very useful for the prevention of accidents in pump service. When cutting a pump in or out of service, it is generally necessary to close two valves on the steam side, and two valves on the water side.

When the swing-gate valve is installed in place of the usual valves, any pump can be readily cut in or

out of service by simply operating the throttle valve. As the steam starts the pump, the swing-gate valves open accordingly. If the pump is to continue in operation any length of time, the swing-gate valves can be thrown out of service if desired, by the operation of the hand wheel, as in an ordinary gate valve.

When used with an open heater, the valve removes any danger to the engine arising from a flooded heater. The swing valve is closed at all times, and an engine can be started up without danger, even if the heater is flooded with cold water.

When used in condenser service, as shown in Fig. 2, it positively prevents any water from flowing into the engine from the condenser, even though the condenser is flooded and the engine is started before the condenser vacuum has been created.

With a swing-gate valve on the exhaust pipe, as shown in Fig. 3, the engine can be started up with the valve closed. If the engine should be started by mistake, without opening the valve, the impulse of the engine piston will drive the exhaust and condensation through the valve, until such time as the cylinder is thoroughly warm, thus preventing any accident to the cylinder.

When used as a back-pressure valve, on an open heater or exhaust system, it may be placed in any position, where it can be thrown in or out of service without changing its adjustment. The position of the swing-gate valve does not affect its operation in service, as it is not controlled by weights. It may be placed in any exposed position, as there are no dash pots or cushions requiring attention, and no water cavities to freeze up.

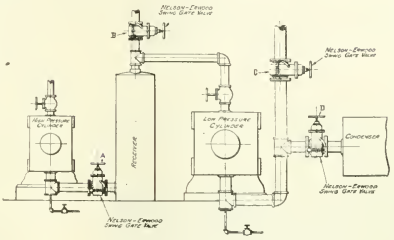


Fig. 2. Swing-Gate Valve Protecting a Compound Engine

In steam-turbine practice, the swing-gate valve has particular application when low-pressure or mixed-flow turbines are used. As shown in Fig. 4, they are placed between the low-pressure inlet to the turbine, and the engine exhaust piping, in order to prevent vacuum backing up into the exhaust piping and drawing in air through leaks and through the piston-rod and valve-stem packings, because air is detrimental to the maintenance of a good vacuum in the condenser. The swing-gate valve is so set that whenever the pressure in the engine exhaust piping falls below 1 pound above the atmosphere, it closes and remains closed until the pressure rises above this point.

Among the many uses to which this valve may be applied, are the following: Back-pressure valve to the atmosphere; atmospheric relief valve on condensing engines and turbines; safety-gate valves on exhaust lines of engines and turbines; safety-gate valve on exhaust lines of pumps, hammers, and elevators; non-return valve between cylinder and condenser; non-return valve between open heaters and engines and turbines; safety-gate valve on lines of air compressors; self-cleaning foot-valve on suction of pump; and combined check and gate valve on discharge of pump. In all these

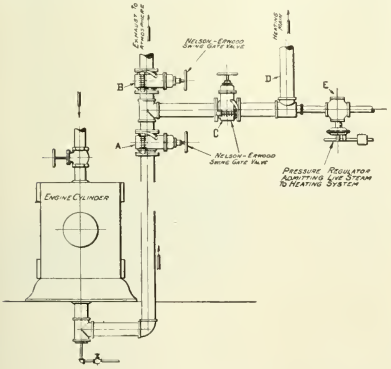

Nelson-Erwood Swing Gate Valve
Nelson-Erwood Swing Gate Valve
Pressure Regulator Admitting Live Steam to Heating System
Engine Cylinder

Fig. 3. Swing-Gate Valve Protecting Non-Condensing Engine

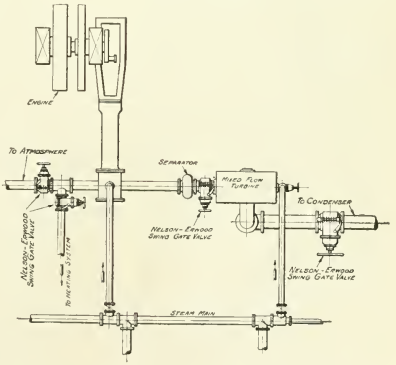


Fig. 4. Swing-Gate Valve in a Mixed-Flow Turbine Plant

applications it can be placed in any position, the spring action controlling the pressure at which it is desired to operate the valve.

Making the Truck Pay

*By H. D. Pratt**

The ability of the motor truck to carry material long distances, and at a high rate of speed, makes it possible to materially reduce the cost of transporting large quantities of coal. The speed of travel is high compared with the horse-drawn vehicle. When unloading, the material is dumped by a mere turn of a lever. The truck may be loaded from overhead by a chute, or from the ground, wherever it is most convenient to store material. The high cost of loading from ground storage is one of the factors which has retarded the sale of auto trucks for this work, because the truck, which carries several tons must necessarily be high to hold the load. Shoveling by hand means that the truck is idle more than half the time waiting to be loaded, and between trucks the shoveling gang is idle. A good average day's work for a shoveler is 20 tons, and not only is the truck idle while being loaded, but loading by hand costs from 8 to 12 cents a ton.

The portable wagon and truck loader shown in Fig. 5 has been designed to reduce loading costs. It consists of a bucket elevator mounted on large wheels, and supplied with power by a motor or gasoline engine. This simple combination will load coal at the rate of a ton per minute, and at a cost of 2½ cents to 5 cents per ton. The saving of about 6 cents per ton thus effected marks the loader as a useful and necessary adjunct of the motor truck.

Fig. 5. Truck Loader

There is also a growing demand for a further combination of truck and loader, namely, a truck with loader elevator mounted on the rear end of the body, arranged to lower into a storage pile when the truck is backed up to it, and also to raise clear of the ground when not in use. The elevator is supported independently of the dumping body, and is driven through a clutch, by a connection to the truck transmission. This combination results in a truck which can be loaded by its driver with or without a helper in a few minutes, and does away entirely with the necessity for a loader-operator who is idle between trucks.

These are made by the Link-Belt Co.

Automatic Self-Dumping Cage

In the new self-dumping cage manufactured by the Henzler & Henninger Machine Works, a simple yet effective method is used to hold the cars in place and assist in rapid caging.

A channel-bar housing overlaps the wheels, and the keepers or dogs engage a cast-iron lug, securely fastened to the car.

Through an arrangement of the levers at the shaft landing, as shown in Fig. 6, the automatic caging of the cars is accomplished. The empty car being released at the bottom, is forced from the cage by the loaded car, and the keeper, which has been tripped to release the empty, is then free to engage the loaded car. The keepers are held in place by coiled springs, and the tilting platform provided with an automatic lock.

Storage-Battery Mine Locomotives

*By A. S. Watson**

The use of storage-battery mine locomotives has been noted several times in The Colliery Engineer, and they have been described in a general way. The fact that such locomotives require no trolley lines and that they can be run into any part of the mine has commended their use to a number of mine managers; but, as is usual, and in conformity with good management, they wanted to know, "what will they do?" "How much dependence can be placed on them?" etc.

In the construction of Section No. 67 of the great Catskill Aqueduct, to supply New York City with water, under the supervision of Messrs.

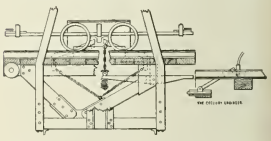


Fig. 6

George Fry and Theodore Bryson, of the Holbrook, Cabot & Rollins Corp., ten storage-battery locomotives are in use 24 hours each day. Section No. 67 extends some 23,000 feet from Fourteenth Street, Manhattan, southeast under the East

*Engineer, Link-Belt Co., Philadelphia, Pa.

*Electrical Engineer, Holbrook, Cabot & Rollins Corp.

River to Flatbush and Third Avenues, Brooklyn.

The locomotives weigh 4 tons each; have a speed of 3½ miles per hour at a draw-bar pull of 1,000 pounds; and a speed of 6 miles per hour with empty trip. They were built by the General Electric Co., and are each equipped with two General Electric automobile motors and controllers. Ball and roller bearings are used throughout.

The battery equipment for each locomotive consists of 44 cells, 225 ampere-hour capacity, made by the Gould Storage Battery Co., and they are charged directly in the tunnel, from charging stations located at convenient points near the shaft.

Ordinary contractors' track of 30-pound rail is used, which is subject to frequent shifting. The cars each weigh approximately 2,200 pounds empty, and 5,700 pounds when loaded. Four cars generally constitute a train.

In the excavation work, 112,724 cubic yards of solid rock were removed as shown in the following table. From August, 1912, to October, 1913, 180,875 cars, a total of 723,319 tons were hauled a total distance of 23,818 miles, on a total current consumption of 55,353 kilowatts, costing $1,383.82, or 2½ cents per kilowatt.

The work was at no time held up or retarded through fault of the batteries or the locomotives. Tons of

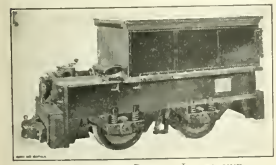


Fig. 7. Storage-Battery Locomotive

dynamite were discharged daily in the 11-foot tunnel headings as near as 500 feet to the locomotives. At such times, though the men were compelled to go to the surface to avoid the terrific concussion, the locomotives were not harmed in the least. In some instances the locomotives traveled distances varying from 500 feet to 4,000 feet under water dripping from the roof in such quantities as to necessitate the motormen wearing "oilskins." Under these hard conditions there was no necessity for battery renewals.

The locomotives are now being used in hauling the concrete for lining the tunnel, and in this work the batteries are being severely overworked. As much as three times the rated capacity of the batteries has been required from them every day, through short boosts between trips, without any trouble. For the past 4 months the batteries have been operating continuously 24 hours per day in addition to the previous year's work hauling rock.

Table 1

Section of Tunnel	Total Length of Tunnel in Feet	Cubic Yards * of Solid Rock Hauled	Muck Cars of Rock	Average Haul in Feet	Number of Locomotives
19 North	2,197	12,446	16,596	1,350	1
19 South	1,912	10,893	13,991	1,203	1
20 North	1,929	12,069	16,090	1,114	1
20 South	2,957	16,370	21,827	1,630	1
21 North	1,276	5,811	7,748	781	1
21 South	1,279	5,475	7,300	815	1
22 North	2,754	14,939	19,919	1,566	1
22 South	3,032	16,042	21,386	1,693	1
23 North	1,711	9,030	12,040	1,047	1
24 North	1,999	10,049	13,400	1,226	1
Total....	21,066	112,724	150,300		10

*One cubic yard solid rock equals 1¼ cars.

The Simplex System

The Simplex system of electric haulage has no overhead trolley nor any third rail, and the tracks thus unobstructed are safe for travel, so far as danger from electric shock is concerned. This avoids the possibility of a whole class of accidents and interruptions of service.

The locomotive is not unlike the ordinary electric locomotive, but the current is supplied to it from

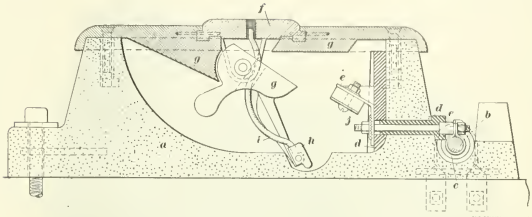


Fig. 8. Section Through Contact Box, Simplex System

contact boxes placed between the rails at distances apart that correspond to the length of the locomotive. These boxes are perfectly "dead" except when the locomotive is directly over them. The feeder cable is carried in a thoroughly insulated conduit buried beside the track.

Fig. 8 shows the method by which the current is delivered to the contact box. The walls and bottom *a* of the box are made of insulating material, waterproofed and of suitable tensile strength. The box is bolted to the ties of the roadbed. The feeder cable *b* is carried in the conduit pipe *c* laid in the trough at the right; *d* is an insulating material running through the end wall of the box and forming a back on the inside; *e* is a copper conductor attached to the feeder cable *b*, and terminating at *j*, which holds a flat carbon brush. The trough containing the feeder cable is filled to the level of its lip with an insulating compound after connection is made to the feeder cable; hence, the contact boxes are connected to the feeder cable and sealed to the conduit pipe *c* and the feeder cable is insulated from one terminal end to the other and can be covered with ballast or earth without interfering with the electrical connection.

The lid *f* of the box is of iron with a center of brass. The armature *g* is suspended from the lid and

terminates in the contact shoe h; the shunt wire i attached to the shoe h and the lid f carries the current when rotation of the armature g engages the shoe h with the contact brush j.

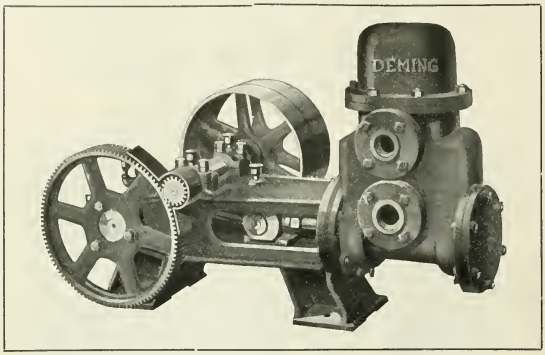


Fig. 9. Mine Pump

Under each locomotive, electromagnets are suspended in such position that they pass directly above the lids of the contact boxes at a distance of 1 to 2 inches from them, and by their magnetism cause the armature g to rotate and make the connection between h and j; the lid f is then "alive."

Electricity is then conveyed from the lid to the moving locomotive by a collector shoe, which make a brushing contact with the lid. To hold the contact armature in place while the entire length of the locomotive passes over, an iron shoe connected with the electromagnets extends the full length of the locomotive, so that before the shoe has passed entirely off one box, it has magnetically engaged the armature in the next one and that lid is then "alive." The armature of the first box drops out of contact by its own weight as soon as the magnetism is removed, and its lid is then "dead."

It is claimed for this system that severe tests have shown the cost of upkeep to be 20 to 25 per cent. less than the overhead trolley; that it can be operated where any other electric system can be used, and that it is safe under all circumstances. When used in mines it has the advantages that if there should be any sparking, it would be at the floor and not near the roof where gas would be most likely to be found.

The system is installed by the Simplex Construction Co., of Harrisburg, Pa.

A New Mine Pump

Coal operators will doubtless be interested in the new horizontal mine pump recently placed on the market by The Deming Co., of Salem, Ohio.

The water end of this pump is a distinctive feature, as the air chamber is built low and broad so that the pump can be taken into low entries, and access to the discharge valves is obtained by removing the air chamber. The water end is made to resist mine water, the cylinder being fitted with a heavy bronze lining. The valves, made of rubber, are mounted on bronze grid seats which screw into the decks.

The bronze piston rod works through a deep stuffingbox with bolted gland. Fig. 9 shows the $6'' \times 6''$ pump which has a capacity of 55 gallons per minute when running at 55 revolutions. These $6'' \times 6''$ pumps are fitted with 3-inch suction, $2\frac{1}{2}$-inch discharge, and are intended for 75 pounds pressure.

Fig. 9 shows the pump fitted with a subbase and with gearing connection for motor; but if it is desired, the motor may be mounted on the main frame of the pump.

The Deming company will be glad to send bulletins to responsible parties. Applications should be made to the home office at Salem, Ohio, or to the distributing houses, The Harris Pump and Supply Co., of Pittsburg, Pa., Henion & Hubbell, of Chicago, and the Hendrie & Bolthoff Mfg. Co., of Denver, Colo., where this line of mine pumps is carried in stock.

Combination Tool for Miners

At times it is difficult to remove all the coal cuttings made when drilling horizontal and downward pointed holes without the aid of a spoon; also on occasions the holes need reaming so that the cartridges can be inserted to the end of the hole without breaking; and always

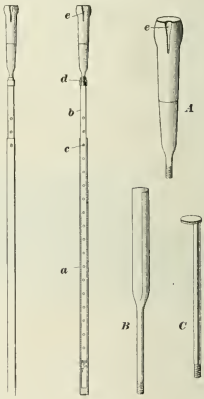


Fig. 10

a wooden tamping bar must be used for high explosives. To overcome these difficulties, Messrs. Shaffer, of Duryea, Pa., got up the tool shown

in Fig. 10, with the three interchangeable parts, *A*, *B*, and *C*. The part *a* is hollow and in it a movable part *b* can be drawn out to measure the depth of the hole or the height of the roof above the floor when a certain length prop is needed. The slide rod is fastened to the hollow rod by a pin passing through holes in the casing *a* which is shown in section and the slide rod *b* at the point *c*. One end of the slide rod has a threaded collar *d* for receiving the threads on the wooden tamping head *A*, the reamer *B* and the spoon *C*. The notch *e* in the tamping head is for the fuse to pass through. We are indebted to J. H. Farrell, foreman of the Twin Shaft for this wrinkle.

The J. C. Stine Duplex Pump

The J. C. Stine Co., of Tyrone, Pa., has recently placed on the market a horizontal duplex, direct-connected electric pump which differs radically in construction from other electric pumps, as may be seen by reference to Fig. 11.

The pump is designed particularly for mine service, and those parts which are likely to come in contact with acid water are supplied with acid resisting Tobin bronze. The power applied to the motor is transmitted through a shaft fitted with a worm and worm-gear reduction, to the cranks which reciprocate the pistons in the water cylinders.

The gears are enclosed in an oil- and dust-tight case, the entire transmission showing, it is said, an efficiency of 97 per cent. Since the cranks are set at right angles to one another, it is apparent when one piston is at the end of the stroke, and for the instant doing no work, the other piston is doing its greatest work.

As this occurs alternately in each cylinder, it is obvious that the load on the motor is nearly constant, instead of intermittent, and greatly reduces wear on all working parts.

The water pistons, piston rods, and the bushings to the cylinders are of acid-resisting metal, as are the eight valve seats, and the valves; however, the latter are shells of this metal filled with vulcanized rubber, the object being to have the casing resist the pressure and shock of seating and so protect the rubber valve. When worn, this arrangement allows the valves to be reversed and so give twice the wear.

Two side plates on each cylinder, when removed, expose the valves for inspection.

The crossheads have large bearing surfaces and are held in place by the bottom guides being part of the pump base, while the upper steel guides are removable and adjustable to take up wear. The pump shown in Fig. 11 is 5 feet 3 inches long; 22 inches high; 18 inches wide, has a capacity of 4,200 gallons per hour and weighs 1,000 pounds with motor.

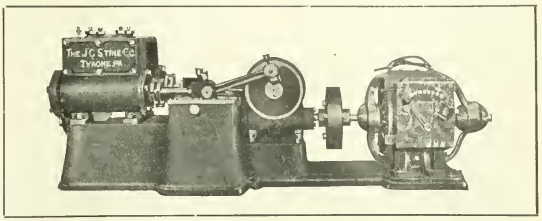


Fig. 11. Electric Pump

Perolin for Boilers

The bad effect of scale in boilers is well known, likewise the difficulty of chemically treating waters containing scale-forming material so that it may not be deposited on the tubes and shell of the boiler. It is always better to keep from getting sick than to call in a doctor and Perolin is compounded on that principle. It is claimed by the manufacturers that no chemical analysis of the feedwater is required, that all necessary to do is to feed enough Perolin after the scale is once removed, to keep the scale from adhering to the boiler metal. The average amount required to maintain a clean boiler is less than one-half pound per 100 horsepower per day.

Perolin works under boiler scale and loosens it from the boiler plates and tubes, but does not dissolve the material. When once the scale is broken free it does not adhere again if Perolin is used in the proper quantities to coat the metal clean. Perolin is sold by the Perolin Company of America, 112 West 37th Street, Chicago, Ill.

TRADE NOTICES

The A. S. Cameron Steam Pump Works, 11 Broadway, New York, announces the opening of a branch office and warehouse in each of the following cities: Birmingham, Ala., American Trust Building, H. M. Perry, Manager; Chicago, Ill., People's Gas Building, M. P. Frutchey, Manager; Cleveland, Ohio, Williamson Building, W. A. Armstrong, Manager; Duluth, Minn., Providence Building, S. H. Hill, Manager; Houghton, Mich., T. F. Lynch, Manager; Knoxville, Tenn., Holston National Bank, L. F. Thompson, Manager; Los Angeles, Calif., W. A. Townsend, Manager; Philadelphia, Pa., Arcade Building, Phil. Weiss, Manager; Pittsburg, Pa., Farmers Bank Building, W. B. Brendlinger, Manager; St. Louis, Mo., 300 North Broadway, A. A. Bonsack, Manager; Seattle, Wash., Colman Building, R. W. Douglass, Manager. These branches will carry a stock of Cameron pumps and repair parts. The Cameron line of pumps includes

single and multistage centrifugal pumps for low-head and high-head service, and a wide variety of steam pumps for use in mining, contracting, power plant, marine and all other kinds of pumping work. Bulletins will be gladly sent on request.

Hazard Mfg. Co.—On May 1, the Hazard Mfg. Co., moved their New York office and warehouse to 531-533 Canal Street, where they will carry a complete stock of wire rope and insulated wire.

Quick Work.—Jones & Laughlin Steel Co. built a coal washery of wood construction at their Aliquippa Works, Pa., in July, 1913. This washery was burned January 6, 1914, and has been reconstructed of steel and concrete and put into operation in 54 days from the time the reconstruction work started. The Link-Belt Co., of Chicago, designed and built both washeries.

The Lidgerwood Cableway Record. Charles H. Locher has handled 6,235,000 cubic yards of material with Lidgerwood cableways while connected with various contracting firms as partner. This represents a mass three times as large as the concrete placed by Lidgerwood cableways at the Gatun Locks, at Panama, the largest mass of concrete in existence.

Compressed Air on the Isthmus. The Isthmian Canal Commission has awarded to the Ingersoll-Rand Co., the contract to furnish three large direct-connected, electrically-driven air compressors of the duplex type, embodying the new Ingersoll-Rogler valve. The combined capacity of these units will be 10,000 cubic feet. They will be installed at the Balboa shops, where the air will be used for general repair work in shops and also on the new dry dock. This equipment is to form a part of the permanent canal equipment.

New Tipple.—The Main Island Creek Coal Co., of which John Laing, of Charleston, W. Va., is president, recently awarded a contract to the Link-Belt Co., of Nicetown, Philadelphia, for designing and building an entire steel tipple, including apron conveyers, for bringing the coal down the hillside, shaking screens, picking tables, and loading booms. The tipple will be erected in the neighborhood of Logan, W. Va.

Western Electric Energy.—On Sunday morning, March 1, the territory embracing the cities of New York and Philadelphia, a semicircular area of approximately 100 miles in extent, was visited by a record blizzard. The April number of the *Western Electric News* states that on the lines of the telephone and telegraph companies in the storm-stricken districts over 6,000 poles went down and these on lines carrying the heaviest loads in the country. A fair idea of the total damage done may be had from the following summary of emergency shipments:

150 carloads of poles, weighing 13,000,000 pounds; 16,000 miles of wire, weighing 2,300,000 pounds; 14,000 cross-arms, weighing 750,000 pounds; 50 miles of cable, weighing 270,000 pounds; 50 miles of strand, weighing 60,000 pounds; 1,000,000 pounds of hardware, tools, tape, connectors, etc.; 200,000 insulators. Total weight of all emergency shipments, approximately 16,500,000 pounds.

New Electric Installations.—Among a great variety of electric mining machinery installed by the General Electric Co., are the following:

Pond Creek Coal Co., Huntington, W. Va., at Stone, Pike County, Ky., eight 6-ton, 250-volt, 44½-inch gauge, electric mining locomotives. The Lehigh Valley Coal Co., Wilkes-Barre, Pa., an 8-ton electric mining locomotive. The Northwestern Fuel Co., St. Paul, Minn., at Washburn, Wis., two 200-horsepower induction motors with switches, transformers, etc. The Sterrick Creek Coal Co., Peckville, Pa., for its mines two new 13-ton, 250-volt, electric mining locomotives. The West Clinton Coal Co., West Clinton, Ind., two 4-ton electric storage battery mining locomotives.

Lighting Device for Acetylene Lamps. In our March number in a notice of the safety lamp igniter, invented and patented by L. D. Vaughn, mine inspector of the Third West Virginia district, it was stated that the device was being adopted by carbide lamp makers. We have been informed that the statement is somewhat in error. Mr. Vaughn's patent is limited to the device used on safety lamps and to its application to safety lamps. The application of an igniter to acetylene lamps was patented on July 29, 1913, by Alonzo Roach, of Linton, Ind., and the patent is now owned by the Dewar Mfg. Co.

The Webster Mfg. Co. have recently moved into their new offices at 1807 McCormick Building, Chicago.

The Crawford & McCrimmon Co., Brazil, Ind., builders of hoists, fans, and lead-lined pumps, have completed and are now operating their new plant, the site covering 9 acres adjoining the city of Brazil. The buildings are of brick, steel, and glass, entirely fireproof, and comprise machine shop, foundry, forge shop, woodworking department, offices, and engineering department. Much new equipment has been installed enabling the company to handle the largest work in rapid order. The entire plant is the result of 46 years of successful work in this line and it represents careful study toward maximum efficiency.

The Ingersoll-Rand Co., announces the opening of a new branch office and warehouse in Los Angeles, Calif., 1036 Union Oil Building. This branch will be in charge of W. A. Townsend, formerly manager of the company's El Paso office. J. D. Foster succeeds Mr. Townsend as manager of the El Paso office. Also the opening of a branch in Juneau, Alaska, under the immediate charge of Frank Carroll. Walter A. Johnson, formerly of Atlanta, Ga., has been appointed Pneumatic Tool Manager of the Pittsburg branch of the Ingersoll-Rand Co., and C. F. Overly, formerly of Pittsburg, Pneumatic Manager of the company's Cleveland branch.

LIBRARY
JUN 8

The Colliery Engineer

l. XXXIV—No. 11 JUNE, 1914 Scranton, Pa.

habetical List of Advertisers—Page 60 Classified List of Advertisers—Pages 62, 64, 66, and 68

170 Quarts Of Nitroglycerine Did not Crack "NATIONAL" Pipe

¶ The following letter, from the user of the piece of "NATIONAL" Pipe illustrated above speaks for itself.

¶ "We recently shipped you a joint of 5 3/16-inch casing for inspection. This joint was part of a liner which was placed in a well near Gore, Ohio, after same had been completed and shot. We decided to give the well a second shot, and placed in same 150 quarts of nitro-glycerine with a 20-quart anchor shot. We then pulled the liner and, after getting it out, we discovered that one joint was still in the hole. We decided to put the shot off with the hope that the joint of liner would come out following the shot. It, however, lodged about 1,500 feet from the top and after working with it for some few days we were able to put a bell socket over same and brought out the joint in the condition that you have found it. Would say that this well was 3,000 feet deep and the 6½-inch casing was not damaged in any way." (This pipe was sold through the National Supply Company.)

¶ Although the original length of the pipe was probably 18 feet, it was reduced by the nitro-glycerine "shot" to about 8 feet. In not one case in a million would the same combination of circumstances arise, even if a person started out to repeat the operation and was so far successful there would be small chance of bringing the crushed pipe to the surface, for it would stick somewhere on the way in the inner casing.

¶ Probably in this actual example there is the best possible demonstration of the toughness of material used in "NATIONAL" Pipe, for the great punishment to which the casing was subjected twisted and distorted it, yet, notwithstanding this, the casing shows practically no fractures. In the one or two places where a slight abrasion occurs, these show by their position they were caused when the material was being drawn out of the hole, and not when "shot."

¶ The holes at the right end were drilled by the chemist for the chemical analysis which showed the material was Bessemer steel.

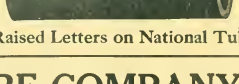
¶ And that is "NATIONAL" Pipe through and through—amazingly tough, and in fact the most satisfactory pipe you can buy. It is such extraordinary instances as this that bring out the superiority of "NATIONAL" Pipe, show its reserve strength and prove it an absolutely reliable pipe for conditions where ordinary pipe is likely to fail.

Write Today for National Bulletin No. 12

This Bulletin has recently been enlarged and revised and contains a summary of information about "NATIONAL" Pipe—When you read it you will keep it on file for permanent use—It's free.

¶ To readily identify "NATIONAL" material and as protection to manufacturer and consumer alike, the practice of National Tube Company is to roll in raised letters of good size on each few feet of every length of welded pipe the name "NATIONAL" (except on the smaller butt-weld sizes, on which this is not mechanically feasible; on these smaller butt-weld sizes the name "NATIONAL" appears on the metal tag attached to each bundle of pipe).

MARKING



¶ When writing specifications or ordering tubular goods, always specify "NATIONAL" pipe, and identify as indicated.
¶ In addition, all sizes of "NATIONAL" welded pipe below four or five inches are subjected to a roll-knobbling process known as Spellerizing to lessen the tendency to corrosion, especially in the form of pitting. This Spellerizing process is peculiar to "NATIONAL" pipe, to which process National Tube Company has exclusive rights.

Name Rolled in Raised Letters on National Tube Company Pipe

NATIONAL TUBE COMPANY,

GENERAL SALES OFFICES
Frick Building, Pittsburgh, Pa.

District Sales Offices:

Atlanta, Boston, Chicago, Denver, Kansas City, New Orleans, New York, Philadelphia, Pittsburgh, St. Louis, St. Paul, Salt Lake City
Pacific Coast Representatives: U. S. Steel Products Co., San Francisco, Los Angeles, Portland, Seattle
Export Representatives: U. S. Steel Products Co., New York City

Make Your Trolley Lines Safe

Surroundings have much influence on the work your men do. They may have the best tools but if they feel *unsafe* they are handicapped.

"SURE GRIP"

clamps keep live trolley wires in their place—safeguard your men from the dreaded danger of falling and hanging wires. The "Sure Grip" clamp is positive. Made in all sizes: 1-0 to 4-0, in malleable iron or bronze for either grooved, round or figure 8 wire.

Electric Railway Equipment Company

Main Office and Works, Cincinnati, Ohio

Address Nearest Office for Catalog 14 and Prices

W. R. Garton Co.
11 Desplaines St., Chicago, Ill.

H. G. Behneman
316 James St., Seattle, Wash.

Cooke-Wilson Electric Supply Co.
Penn Ave. and 3d St., Pittsburg, Pa.

Cooke-Wilson Co. of Ohio
714 Columbia Bldg., Cleveland, Ohio

Cooke & Wilson Co.
Charleston, W. Va.

Superior Supply Co.
Bluefield, W. Va.

Mine & Smelter Supply Co.
Denver, Colo.

Mine & Smelter Supply Co.
El Paso, Texas

Mine & Smelter Supply Co.
Salt Lake City, Utah

C. M. McClung & Co.
Knoxville, Tenn.

McClary-Jemison Machinery Co.
Birmingham, Ala.

J. G. Kipp, 30 Church St.
New York City, N. Y.

Grayson Railway Supply Co.
405 La Salle Bldg., St. Louis, Mo.

Arthur L. Ware
Jellico, Tenn.

HOISTING ROPES **HAULAGE ROPES**

Rubber Covered Wire — Mining Machine and Locomotive Cable — **Bare and Weatherproof Wire**

HAZARD MFG. CO.

WILKES-BARRE, PA.

NEW YORK
533 Canal St.

PITTSBURGH
1st Nat'l Bank Bldg.

CHICAGO
552 Adams St.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh
Chicago Savannah Cleveland
(Office Atlanta)
San Francisco Los Angeles
Seattle Portland, Ore.

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

Formerly Mines and Minerals

XXXIV—No. 11 JUNE, 1914 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.
ESTABLISHED 1891

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. FOSTER, President S. P. ALLEN, Secretary E. H. LAWALL, Treasurer
RUFUS J. FOSTER, Vice-President and Managing Editor
EUGENE B. WILSON, Editor WM. Z. PRICE, E. M., Asst. Editor
CHICAGO OFFICE: 1006 S. Michigan Ave.

Entered at the Post Office at Scranton, Pa., as second-class matter
Address all business communications to THE COLLIERY ENGINEER, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give you FORMER as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE, 15,000

TABLE OF CONTENTS

Editorial—
The Force That Is Molding the World—The Eccles, W. Va., Mine Disaster—Explosibility of Anthracite Dust—Coke 651
Personals 654
Stripping in Anthracite Region, by Wm. Z. Price 655
Methods of Utilizing Small Coal and Slack, by T. Moorhie 658
Robbing Mine Air of Its Danger, by William H. and Sim Reynolds 659
The Issaquah Coal Mine, by George Watkin Evans 663
International Engineering Congress, 1915 666
Bridges or Brains 668
The Somerset Mine of the Utah Fuel Co., by B. P. Manley 667
Obituary—
James Andersen—George F. Baer 672
The Azcol Process of Preserving Mine Timbers 674
Kentucky System of Land Surveys, by W. T. Griffiths 675
The Meridiograph 677
The Training of Rescue Brigades 678
Electro-Pneumatic Air Compression 681
A Lecture on Technical Reports 682
Manufacture of Briquets in Holland 682
Rectangular Coke-Oven Plant, by W. N. Judd 683
Technical League of America 685
A New Rock Plane 686
Belgian Haulage Tests 686
Efficiency Expert 686
Practical Lubricating Tests 687
International Study of Coal Dust Problems 688
Natural History of Coal Dust, by E. B. Wilson 689
The New Owner of the Temple Iron Co's. Collieries 689
New Executives for Prominent Anthracite Companies 690
Neutral Coke—Diehle-Faber Process, by J. R. Campbell 691
Saline County First-Aid Meet 692
Explosion at Oberhausen Colliery, Germany 693
Big Business and Mining, by Charles Richard Van Hise 694
A Successful Miners' Course 698
The Letter Box—
Open Lights in Well-Ventilated Mines—Qualifications for Certificate in Alberta—Ventilation and Fire—Anthracite Dust—Miner's Inch—Haulage Problem 700
Pennsylvania Anthracite Section, A. I. M. E. 701
Explosion Not Caused by Acetylene 702
The Trouble in Colorado 703
Illinois Mining Institute 705
Notes on Mines and Mining 706
Examination—
Mine Foremen's Examination at Sheridan, Wyo., 1914 707
Catalogs Received 710
Book Review 711
Idaho Coal Beds 711
New Mining Machinery—
Four-Cylinder Triple Expansion Engine, 712—Roller Bearing Wheels, 712—The Morris Bit Machine, 713—Nelson Non-Return Valve, 713—Shaft Stairway, 714—Feedwater Difficulties, 714—Hinkel Automatic Safety Stop, 714—A Gathering Locomotive for Low Coal, 715—Self-Contained Portable Pumps 715
Trade Notices 716
Eureka 716
Squibs—
Anthracite Supplies, 658—Volume of Salt in Ocean, 674—Texas Miners, 686—Be Careful of Carbide, 690—Exploders, 693—Days Miners Work, 699—Cost of Mules 702

The Force That Is Molding a World

THE man who can move a product, the man who can move an idea or a thing from where it is made to where it is used and bring back something of value in exchange is the force that is now molding and making the world of which each of us is a part.

We are paid to deliver a thing from *"here to there"* and bring back something in return. The problem of civilization, the problem of each firm and of each business man is to set each man at work doing that which he can do best.

Each of us should be a producer, should be at work where we can show results. We are paid, or should be—and some of us are—for our ability to produce. Land is worth what it will grow when intelligently cultivated. Real estate is worth what it will bring because of accessibility and location. What will it bring? What can he produce? This is the principle that underlies it all.

The man who uses other men to help and to lend a hand in the great scheme of usefulness is the man that gives opportunity. And opportunity means life and liberty and love and success and health and happiness. And these are the only things that are really worth while.

Each of us is paid for doing something that needs to be done, but too many of us are able to do nothing that any one wants done. Too many of us have no trade, no skill, no training. There is nothing we can make or sell or buy, and consequently we possess no desire to perform useful service because we do not understand what service means.

Our present method of training young men during the early and all-important years of life is wrong; and worse, it is travesty; and more than this, it is a crime against the race and against the individual who suffers. We grow up to manhood without a trade, without an occupation, without anything the world can use in moving something from *"here to there"* and bringing back something of value in exchange.

The man, or the boy that must earn a living should be trained to do something well, skilfully—for these are the things that count in molding and making an individual that improves the standard of things about him.

My heart goes out to the man who is lost in the work he is paid to do, whether that man is welding a rivet in the structure of a skyscraper; whether he is painting a tower or working in tile. Whether he stands at a wheel

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

in the mill or at a machine in the shop. Whether he is writing a book or painting a picture—my heart goes out to that man whose mind, whose soul and whose religion are riveted to the thing he has selected as his part in the Scheme of Life.

To those who are toiling in the mines; inventing machinery; weaving the cloth that clothes the world; to those who are driving our engines of power and guiding our trains across the continent; to those who are working in our offices of business; to those who are breeding better plants and growing flowers to feed our souls with beauty; to those who are spanning our streams with structures of steel; to those who are training their hands and minds to do something useful here in the great scheme of building a race of men—my heart goes out to them across the miles.

For all these we need finer homes, better foods, finer clothes, better books, cleaner newspapers, better shops, safer travel, more parks and more playgrounds for recreation and change; and when we begin to teach our children to do the thing they are best fitted to do, so that they will be able to render a service the world is willing to pay for, then and not until then will we have all of these things.

The problem of civilization is to set men at work doing that which they can do best; for the individual of this type sets a higher standard for everything touched by his money and intelligence.

Everyman

The Eccles, W. Va., Disaster

At this writing nothing definite has been determined as to the causes that led up to the explosion at the New River Collieries Co.'s No. 5 Eccles mine in Raleigh County, W. Va., on April 28, by which 180 persons lost their lives. The mine was not so extensively developed as to present any difficulty in providing ample ventilation to all the working places. Although a little gas could be detected at each working face, neither Mr. John Laing, former Chief of the Department of Mines of West Virginia, nor his successor, Mr. Earle Henry considered the mine so gaseous as to require the exclusive use of safety lamps. Therefore, the mine has been worked, ever since it was opened, with open lights.

The officials of the mine, from the president of the company, down to the fire bosses, are experienced in coal mining. To insure safety from all dangers, a fire boss and two inspectors were constantly in the mine. No man, after firing a shot, was allowed to enter his working place until it had been inspected by a company official and pronounced safe. Brattice cloth was stretched from the last breakthrough to the face of every working place to insure abundance of air to each miner. The mine was generally wet and was watered wherever it was found to be dry, and the hygrometric readings averaged 98 per cent. humidity. Every precaution to insure safety, except the use of safety lamps, was adopted, even to the exclusive use of the permitted explosive, "Monobel."

The management will probably be criticised for permitting the use of open lights (although such lights are used in anthracite mines where gas is more abundant), particularly as in the future safety lamps will be adopted for use in this mine. But, before passing judgment on the management of the mine, readers should weigh the following carefully:

It is generally accepted that dust played but little part in this explosion and that it was a general gas explosion. While no one ventures to definitely assign a cause for the general distribution of gas in an explosive mixture throughout the mine, several theories have been advanced, but as yet they cannot be substantiated. The accounts of the explosion received from reliable men indicate that it was general throughout the lower seam workings, extending into rooms and remote corners, and that it traveled up the air-shaft into the overlying seam where considerable damage was done in a portion of the upper seam workings, but not so much as in the lower seam.

One theory advanced is that there may have been an outburst of gas, although no outburst had ever previously been known in that neighborhood. Another theory is that it may have been due to some one leaving a door open and by short-circuiting the air gas was allowed to accumulate, into which some one walked with a naked light. Either one of these conditions would cause a local explosion, and not a devastating one that would extend throughout the mine and up the air-shaft, and into the workings of an overlying seam, as was the case in this explosion.

Three days before the explosion there was a period of high barometric pressure; on Monday the mercury commenced to fall, and on Tuesday, at 2:30 P. M. the explosion occurred. The falling barometer might have permitted an unusual exudation of gas at every working face, and then if either of the two above mentioned conditions prevailed, it might account for the explosion being so general throughout the mine. No one could foresee this explosion.

The mine management and Chief of the Mining Department of West Virginia have been and are using every effort to conserve life and lessen danger in mines, and this explosion came like lightning from a clear sky.

The superintendent, a mining engineer who knows every corner of the mine, went into it every day; several times a week the manager, who is an experienced mining engineer and a former mine manager at Cokedale, Colo., went into the mine; once a month the president of the company, one of the most experienced mining men in the country, personally went into the mine with the manager, superintendent, and inside foreman, and with

them, on the spot, consulted on what was best for the safety of the men in the mine.

No one can justly accuse these men of negligence when it is remembered that they were so frequently in the mine themselves.

It is probable that a number of conditions prevailed which individually would not have caused this disaster, but which happening collectively produced the unexpected. The management should not be prejudged. Chief Henry, of the Department of Mines of West Virginia, and the officials of the United States Bureau of Mines, will, as soon as possible, investigate the conditions of the mine under normal working conditions, and will endeavor, if possible, to discover the causes that led up to the disaster.

In our next issue we expect to furnish our readers with a detailed description of the mine, the explosion, and such information as to its causes as may be developed.

Explosibility of Anthracite Dust

ALMOST any pure vegetable matter when dried and converted into impalpable powder will explode, owing to its being in a condition suitable for quick combustion. To obtain combustion there is a decomposition of substances and the immediate formation of other substances. An explosion is quick combustion accompanied by light and heat, and the quicker the material is decomposed into gas, and the gas expanded by the heat of combustion, the greater will be the force of the explosion. A certain coal journal printed the following under the heading "Explosibility of Coal Dust": "The scientific conclusion therefore is that the violence of a dust explosion depends, *not on the volatility of the coal, but on the calorific value of the dust.* If this be true, anthracite dust, though difficult to inflame, will ultimately produce an explosion *as violent as those* produced by *high-grade bituminous coals.*"

While it is a well-established fact that the calorific value of a substance may be obtained by slow combustion as well as quick combustion, the question of explosibility evidently does not depend on this value, but rather on the volatility of the substance that explodes. The Bureau of Mines failed to explode anthracite dust for the reason that anthracite is a metamorphosed substance, not readily volatilized and therefore not in condition for quick combustion. The result was predicted before the experiments were undertaken, because powdered anthracite sifted on a flame scintillates instead of flaming like soft coal, and this alone is sufficient to indicate the non-explosibility of Pennsylvania anthracite dust. As the leading technical coal journal in the United States, The Colliery Engineer is frequently required to correct mistakes in other coal journals, which, if not corrected, would lead to the impression at home and abroad that all were unreliable in their technology. It is with reluctance therefore that attention has to be called to the two misstatements quoted and to be obliged to explain that calorific value does not seem to enter into the problem of coal dust explosibility, while the volatility of coal dust is the prime factor. It has also been noticed that semi-technical and non-technical men frequently confound calorific value with temperature, when there is much difference between the two.

Coke

IN 1912 there were 102,230 beehive coke ovens in the United States, which produced 32,868,345 tons of coke, using in the operation 49,302,517 tons of coal. The average yield per ton of coal carbonized was 65* per cent. which means 35 per cent. of the coal was wasted, that is 17,255,881 tons worth $4 per ton. The price of $4 per ton is obtained as follows:

Edward W. Parker states that the tar, ammonia, and gas obtained from carbonizing 12,490,757 tons of coal in the gas works and by-product ovens of the United States in 1912 were valued at $50,003,209, which makes the value of the by-product a little over $4 per ton, but the value of the coke was $48,380,000, hence total value of coke and by-products amounted to $98,383,208 or $7.87 per ton. Using this value per ton for the number of tons of coal coked in beehive ovens, in 1912, there was a money loss of $388,010,707. This is based on the assumption that coke-oven gas has the same value as illuminating gas, which is not always the case; however, the advent of the by-product oven in cities would greatly decrease the price of gas to consumers, and leave a large profit to the gas makers. It is probable that the loss in coking the 49,302,517 tons of coal in beehive ovens in 1912 was more than $200,000,000. Mr. Parker stated† that "80,000 horsepower, or less than one-half of the total quantity of horsepower wasted (from 40,000 beehive ovens) every hour of the day for 365 days in the year, in the Connellsville districts, would pull every train on the Pennsylvania Railroad between Pittsburg and Harrisburg"; and this being the case, the total energy wasted (180,000 boiler horsepower) would haul all the trains from Pittsburg to Jersey City.

In 1893 the retort, or by-product, coke oven was introduced in the United States by the Semet-Solvay Co., of Syracuse, N. Y., which built 12 ovens. In 1914 there are over 5,000 such ovens. In 1912, 11,115,164 tons of by-products were produced, also 54,491,248,000 cubic feet of surplus gas; 94,306,583 gallons of tar; 51,527,074 pounds ammonia; 35,242,549 gallons of ammonical liquor; and 99,070,777 pounds of ammonium sulphate. Napthalene and benzine could have been produced, and will be in the future thus adding another fruitful source of revenue to the revenue from by-product ovens.

*Sixty-six per cent. given by Mr. E. W. Parker, United States Geological Survey.

†Transactions American Institute Mining Engineers, Bulletin 73, January, 1913.

PERSONALS

G. W. Ireland, through the reorganization of the office management of the Jamison Coal and Coke Co., became sales manager of the coke department. Richard Donaldson was made manager of the coal department, both offices being formerly handled by the late Mr. Johnson as general sales manager.

Edward I. Martin, of Columbus, Kans., has been appointed receiver for the Pratt-Durkee Coal Co., operating near that city. The receivership was established at the request of officers of the company.

William Hahman was recently appointed receiver for the Lilly Coal Co. The receivership was caused by the death of Dr. H. J. Evans, some difficulty arising in the settlement of the interests of the estate of the deceased in the valuable property and assets of the company.

The Pittsburg-Buffalo Coal Co. announce the appointment of Harry Brown, of Burgettstown, Pa., as mine foreman at their Hazel mine near Canonsburg, Pa.

John I. Absalom, ex-state mine inspector of Montgomery, W. Va., has been made general superintendent of the Coal-Bell Coal Co., at Scotford, W. Va.

W. O. Garvin was made president of the Trenton (Mo.) Coal and Mining Co., at the annual election recently. Other officers are H. F. Hoffman, vice-president; G. M. Woltz, secretary; and W. E. Austin, treasurer.

C. H. Nesbitt, of Birmingham, Ala., and K. F. Webb, of Walker County, have been reappointed chief mine inspector and associate mine inspector, respectively, by Governor O'Neal for a term of 3 years.

E. Drenner, manager of the Elkhorn division of the Consolidated Coal Co., Jenkins, Ky., has resigned to become vice-president of the Stonega Coal and Coke Co. with operations in Virginia, Kentucky, and Tennessee.

M. H. Boyer, division sales manager of the McAlester (Okla.) Fuel Co., with offices at Kansas City, has resigned after 10 years service with the company. He has been succeeded by C. H. Hightower, former general sales manager of the company.

The annual meeting of the Southern Appalachian Coal Operators' Association to have been held April 24, was postponed indefinitely owing to the fact that Edward C. Mahan, of Knoxville, Tenn., vice-president and general manager of the Southern Coal and Coke Co., and president of the association, was ill with typhoid fever.

J. W. Powell, formerly of Coleman and Bellevue, Alberta, and afterward with the Columbia Coal and Coke Co., in the Tulameen country, British Columbia, is now superintendent for the Cottonwood Coal Co., at Windham, Mont.

A. H. Wood, mining engineer, of Petros, Tenn., who for some years past has been engaged in special mining engineering and construction work, has decided to again take up expert work, largely in a consulting way. During his 22 years of work he has had opportunities to acquire large experience in the Appalachian coal fields and in the construction of plants for mining and treatment of the coals of that region.

Joseph Northover, who has been assistant foreman for the last 3 years at Eureka No. 39, Berwind-White Coal Mining Co., Seanor, Pa., has been promoted to the position of mine foreman.

The newly formed Chicago Section of the American Institute of Mining Engineers, held its first annual dinner and meeting at the Sherman House on the evening of April 14. The officers elected were: Chairman, Robert W. Hunt; vice-chairman, J. C. Ede; secretary-treasurer, H. W. Nichols; executive committee, F. K. Copeland and G. M. Davidson.

John Hunt is now general superintendent of the Western Fuel Co.'s several coal mines in the neighborhood of Nanaimo, Vancouver Island, B. C., for which company Mr. Thomas R. Stockett has for years been general manager.

J. Parke Channing, the mining engineer, announces the removal of his offices to the 18th floor at 61 Broadway, New York City.

The new mine inspectors for Illinois have been named as follows: First District, Benjamin Roberts, Streator; Second District, Thomas H. Devlin, Spring Valley; Third District, Patrick Hogan, Canton; Fourth District, D. Z. Thrush, Farmington; Fifth District, J. W. Starks, Georgetown; Sixth District, Thomas P. Back, Springfield; Seventh District, Archie Frew, Gillespie; Eighth District, John Kaney, Centralia; Ninth District, William Hartman, Belleville; Tenth District, John McClintock, Murphysboro; Eleventh District, George L. Morgan, Benton; Twelfth District, John Garrity, Marion, Ill.

F. A. Jones, president of the New Mexico School of Mines, has been appointed Director of the New Mexico mineral exhibit, at the San Diego Exposition and is making a tour of the state, creating interest in the exhibit.

Hywell Davis, of Lexington, Ky., has been appointed by Secretary of Commerce and Labor Wilson as one of the committee to investigate the conditions in the Colorado Coal fields. Mr. Davis is well equipped to, and undoubtedly will perform his duties in a conservative and proper manner.

E. T. Stotesbury, has been elected president of the Reading Co.; Mr. Theodore Voorhees, president of the Philadelphia & Reading Railway Co.; Mr. W. J. Richards, president of the Philadelphia & Reading Coal and Iron Co.; Mr. W. G. Besler, president of the Central Railroad of New Jersey; and Mr. Charles F. Huber, president of the Lehigh & Wilkes-Barre Coal Co., vice the late George F. Baer who was president of each of the aforementioned corporations.

COAL MINING & PREPARATION

Stripping in Anthracite Region

The Nature of Some Strippings—How the Work is Carried On—The Amount of Overburden Stripped as Compared With Coal Recovered

By William Z. Price

IN a number of places in the anthracite field, it is found practical to strip the overburden of the coal and mine it in the open. The seam uncovered is usually the Mammoth, and its thickness varies considerably. Strippings are commonly canoe-like in shape where the basins are shallow, but where the seam pitches steeply to great depths as is sometimes the case, the overburden is stripped only to the "no-profit" line.

Some strippings uncover virgin coal, while others bring to light pillars near the outcrop, left standing since the days of early mining. In many cases the old chambers are caved shut, and the recovery of the pillars by stripping is the only method available.

It is common belief that the coal from strippings is cheap coal. In many cases it is equally as costly as that mined underground, the advantage being the complete mining, or a recovery of almost 100 per cent. as compared with 75 to 80 per cent. in the inside workings.

The expense of timbering, ventilating, and pumping is omitted in strippings, but this fact enables the companies to strip the coal to greater depths than would otherwise be the case. At some collieries where the cost of underground mining is abnormally high, but having a stripping easy to mine and the transportation of the coal to the breaker is cheap, the average cost per ton of mining is lowered, enabling the working of both systems. The converse is likewise the case, cheap mining underground warranting a more expensive stripping. Thus the shipments are increased and the life of the mine is conserved, making the conditions beneficial to employer and employe.

No fixed rule can be made as to the number of cubic yards of overburden that can be stripped per ton of coal to be laid bare. Circumstances alter cases in mining as elsewhere, and the thickness and pitch of the seam together with the nature of the cover are extremely variable factors.

At the Morea colliery of the Dodson Coal Co., in the northern part of Schuylkill County, and at the eastern end of what is known as the Western Middle Anthracite Field, the cover above the coal is soil and below this, rock, which in the center of the basin reaches a thickness of 80 feet and will average about 20 feet. In other places in the basin there is only a thin cover, but fortunately where the cover is the thinnest the coal is the thickest, thus balancing up the differences in the cost of removing the thicker covering. At Morea the soil is removed by steam shovels. The rock is then blasted, and loaded by the shovels into mine cars and hoisted out of the pit. After the coal has been cleared

Stripping at Reliance Colliery—Steam Supplied to Drills from Locomotive

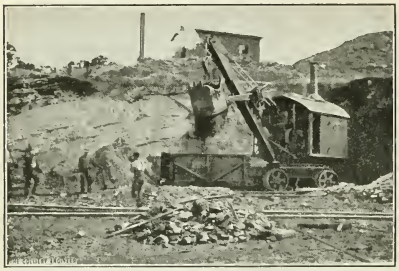
of the rock for a sufficient distance, vertical drill holes are put in the coal. As there is a vertical wall of coal, a small quantity of powder properly placed brings down a relatively large quantity of coal.

At the Green Mountain strippings, southwest of Hazleton, the A. E. Dick Construction Co. has a contract with the Lehigh and Wilkes-Barre Coal Co., for stripping about 2,000,000 cubic yards from the Mammoth seam. The cut is approximately 5,000 feet long by 500 feet in width.

The Lehigh Valley Coal Co., is operating two important strippings near Centralia. At the North Ashland stripping the Rhodes Contracting Co. is removing an old culm bank in addition to the cover in order to strip the Mammoth seam, which is 25 feet in thickness and has a pitch of 25 degrees at that place. They are using a 70-ton Bucyrus shovel for the stripping of the cover and a 30-ton Marion shovel for the coal, which is transported to one end of the stripping where it is dumped into a chute leading to a gangway on the bottom level 900 feet below.

The culm bank over the coal is a prominent feature. It is always important to carefully consider the selection of the land used for the dump from the stripping, or for a culm bank, for if it is underlaid with coal, as is the case there, it means a two-fold handling of the refuse.

Philadelphia & Reading C. and I. Co. Operations.—The Silver Creek strippings of the Philadelphia & Reading Coal and Iron Co. are situated about 3 miles north of New Philadelphia, Pa., and are of but small area at present. The Mammoth seam is present in three splits and in a somewhat faulted condition. The cover of loam and rock has to be removed to a depth of from 15 feet on one side of the cut, to 65 feet on the other. It is difficult to estimate the thickness of the coal at this point, due to its distorted condition. A fault divides the stripping into two sections. On the north side the cover is already removed and the shovel is taking out the coal. All the burden has not been removed on the south side. The coal goes down a plane to Silver Creek colliery.



Silver Creek Stripping, North of Fault

Silver Creek Stripping, South of Fault

At the Bear Run strippings, 2 miles west of Mahanoy City, Pa., the area to be uncovered was divided into three sections. While the contractor strips the second section, the company mines out that one already uncovered. The first section, approximating 1,200 feet long by 500 feet wide, has been stripped and coal is being mined. In this section the cover was stripped to a depth of 65 feet on the north to the outcrop on the south. There is a divider in the coal between the middle and bottom splits of the Mammoth seam. This divider is from 2 to 3 feet in thickness and is either gobbed or hauled away, that depending upon the amount of space available.

In the three sections according to the estimates, there are:

First section, 620,000 cubic yards of cover to be removed for 185,000 tons of coal to become available, or a rate of 3.3 cubic yards per ton of coal.

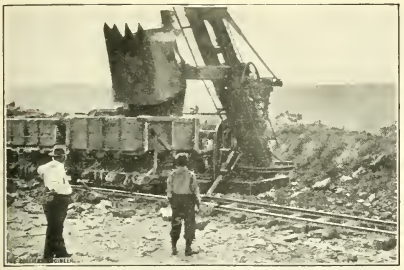
Second section, approximately 1,000 ft. × 400 ft. in size, 300,000 cubic yards of cover for 90,000 tons of coal or a ratio of 3.3 to 1.

Third or western section, measuring 1,600 ft. × 300 ft., 655,000 cubic yards of cover for 171,000 tons of coal or 3.8 to 1.

The entire area totalling 1,575,000 cubic yards overlies 446,000 tons of coal, thus approximating the removal of 3.5 cubic yards per ton of coal. The average total thickness of the coal is 25 feet.

The coal is taken to the head of a single-tracked plane at the eastern end of the strippings. The cars are lowered and hoisted by a 10″×12″ Flory engine. The plane extends down the hillside 260 feet, when it becomes a slope for 150 feet farther. The cars are then taken by electric locomotives 1,600 feet out to the drift mouth near the breaker.

At the western end of the stripping the shovel is getting so low on the pitch that the loaded trip, locomotive, and dump cars as well, are hoisted up a 5-per-cent. grade, for 700 feet to the level of the top of the bank. A 14″×20″ Vulcan engine, with 1¼-inch rope is used for this work. This stripping was started in November, 1911. The Dick Construction Co. are using an 80-ton Bucyrus shovel for removing the overburden. It averages one hundred and twenty-four 5-yard dump cars a day.



Bear Run Stripping

Ellangowan Stripping

The Mahanoy City Colliery stripping, situated about 1½ miles northwest of the town of that name, is divided into two parts by the Lehigh Valley railroad tracks.

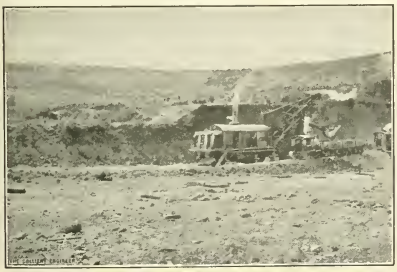
In the eastern section, measuring 300 ft.×1,400 ft., the coal is dumped from the cars into a chute in an old chamber. This chute leads to a water-level gangway where the coal is again run into cars and taken out of the slope with the underground coal. The top split of the Mammoth seam is stripped here. It is 16 feet in thickness and 260,000 cubic yards of cover, consisting of shale, slate, and sandstone, were removed for 70,000 tons of coal, or a ratio of 3.6 to 1.

The western section measures about 250 ft.×2,000 ft. and is L shaped. The surface here overlies not only the old pillars, but about 8 feet of top coal in the chambers. These were worked by Hill & Harris many years ago before the colliery was taken over by the present company. Over 100,000 cubic yards of cover have been removed but very little mining has been done.

The Ellangowan stripping, west of Mahanoy City, is 400 feet wide and 2,600 feet long. It is the company's intention to make it 400 feet longer in the near future. In the western part, the top, middle, and bottom splits of the Mammoth are mined, while the bottom split only is available in the eastern section. The others are eroded or are under fan houses, dwellings, etc. In the western section the parting between the upper seams is from 10 to 12 feet and one of similar thickness lies between the lower seams. The method of operation is to strip and mine alternately. The eastern section overlies old workings operated years ago. The chambers were mined until the roof weakened and it was then believed that they were near the outcrop. Recent surveys, however, showed that there was coal farther on up the hill. Accurate cross-sections showed that there were about 100,000 tons of virgin coal which could be recovered by stripping, in addition to the pillar coal. Since the stripping began in June, 1905, over 625,000 cubic yards of cover have been removed and over 120,000 tons of coal have been mined since March, 1907, or a ratio of 5.4 to 1. The estimate of the complete operation is 800,000 cubic yards of cover to 265,000 tons of coal or about 3 to 1. A 70-ton Bucyrus shovel is in use for removing the overburden and dumping into 3½-cubic-yard cars. The coal is taken by locomotives around the mountainside to the head of a self-acting plane where it is lowered to the breaker level.

Besides the contract work, the company did some excavating here. They made a cut 500 feet long, 30 feet wide, and 30 feet deep, through the outcrops to prove the coal. This was later used as a haulage road but is now obliterated.

At the Reliance strippings, 1½ miles south of Mt. Carmel, Pa.,



Mahanoy City Stripping, Western Section

Mahanoy City Stripping, Eastern Section

similar conditions exist, save that the seam pitches more steeply, being at 30 degrees there. It is 22 feet in thickness and it is estimated to remove 450,000 cubic yards of cover for 250,000 tons of coal, or a ratio of 1.8 to 1. Two 70-ton Bucyrus steam shovels are engaged in removing the overburden. The coal is taken to the Reliance breaker which is situated to the east of the stripping.

Methods of Utilizing Small Coal and Slack

By T. Moehrle

In the modern methods of utilizing the slack and small coal, it is necessary to convert it into fuel at the pit mouth, as, after washing, it contains too much water to transport. The problem is how to employ the heat units in the slack to the best advantage by combustion under boilers. The usual system is

Bear Valley Stripping, Showing Chambers Uncovered

Morea Stripping

At the Bear Valley strippings, about 8 miles west of Shamokin in the valley of that name, the three Mammoth splits are present. They total 36 feet in thickness with intervals of 10 and 15 feet of rock. The seams are pitching 60 degrees, and after the shovel takes off the cover the coal is mined by hand. The roof is extremely bad and with the pitch and thickness of the seam it is impossible to get the coal by underground mining.

The stripping of coal is a large proposition and this is seldom realized. The cost includes, coal for locomotives and shovels, a locomotive house, the excavation of cover by the contractor, the excavation by the company, which means cleaning out falls, slate partings, etc., together with constructing a haulageway to the plane or breaker, connecting the stripping tracks to those leading to the breaker, and the construction of the necessary buildings, such as tool house, powder house, blacksmith shop, locomotive house, and water lines.

to carry off the water and slack to settling ponds, either stepped or connected with each other by sieve plates. In another arrangement the slime and water are admitted to a vat, and, as soon as the coal has settled the water is run into a second vat, and the coal left behind is recovered. The disadvantages of these methods are that they require much space, and are difficult to carry out in winter. The slime contains from 50 to 60 per cent. of water.

The coal thus recovered is sometimes carried off on a traveling dredger, or discharged on to a truck running the length of the settling vats. In the Wold-Waldenberg system, an elevator with a movable bottom, from which the contents are easily discharged, is substituted for an elevator of the usual kind which is apt to become clogged, owing to the greasy and caking condition of the coal. The bottom of the elevator is kept clean by a moving scraper, but the machine is costly. In the pneumatic Schubert patent, the slime is contained in a cylindrical vessel placed between an air pump and a suction pump, and the cylinder is alternately exhausted and filled by means of the vacuum thus formed. In another arrangement compressed air only is used, and no suction; but these systems deal only with the wet slack, and do not dry it. In a new method the washed slack is treated in an air cylinder fitted with an agitator. The water is first mechanically separated from the coal, and the latter then forced by a compressor into a series of box presses or molds. The slime contains about 25 per cent. of water, which is extracted in the presses, and is quite clear when discharged. The finished product in the form of briquets, is emptied into trucks, and is ready for use as fuel. This system has been satisfactorily worked at a mine in Weisstein. Elsewhere the briquets are raised by an elevator, and delivered on to a traveling belt. A firm at Hamburg conveys the slack and slime through troughs along a small, electrically driven aerial railway. With modern mechanical stokers, the slack, after this treatment, can be continuously fed to the boilers, provided that the grates on which it is burnt are suited to it.

Anthracite Supplies

The anthracite mine operators of Pennsylvania purchase $28,233,000 in supplies yearly. They purchase about $600,000 worth of water yearly.

Robbing Mine Air of Its Danger

Principles Governing the Cause, and the Method of Applying Steam to Reduce the Dangers of Dust in Mine Air

By William H. and Sim Reynolds

In common with many other writers to the mining press whose work tends to pave the way to a wider knowledge of safe methods, we have the failing of sometimes taking for granted that because we who write have these indirect details firmly planted in our minds the reader does also, which is not always the case. And like the horse that was lost for the loss of a shoe, some mine far distant from where the paper was written may continue on into ultimate disaster, while but for the lack of a little more explaining a safer method might have been tried and prevented the tragedy. For as the principles which govern the application of any method vary according to circumstance and location, so might an installation which proved practical in one bed or parts of a bed, be impossible or positively dangerous in another. This is a vital subject which the managerial reader will do well to consider. To follow blindly in the path traversed to success by another, may under different natural or man-made conditions prove cause of regret, if not actual ruin. The careful writer will state only the facts as they occurred, and leave the suggestion as to their treatment elsewhere to the common sense and judgment of the man on the spot. He will explain the mode by which it was put into practice at his own mine, or at others under his observation, then leave the possibility of its being applicable to the reader. Under similar conditions we do not doubt that the method detailed will serve admirably for any mine manager, but only under those conditions.

To those not familiar with the "Pittsburg coal," or what is locally termed the "Pittsburg thick," or the "Pittsburg thin," depending on the slightly varying height in different localities, or the "Pittsburg No. 8 seam," we may state that while more regular in many physical manifestations than are most beds of equal extent, it differs radically in dust propagation. Also with respect to the transpiration of gas, the mines opened in the southern end of Washington County, differ radically from the mines nearer the city of Pittsburg. The mines are deeper as one goes south, and all who work in it or visit it will readily admit that it is indeed a "dusty" field, and far from deficient in the matter of gas. Both elements of extreme hazard are in such evidence that the careful mine manager grasps the fact at the very start of his official career in that field that eternal vigilance is indeed the price of safety there. And if he desires to complete any length of service himself he will not fail to enforce it on others, too. Yet not always in the Pittsburg mines is this the case. We recall an instance of our boyhood which will exemplify this difference very clearly.

We had gone to work in the old Scott-Haven mine, much nearer Pittsburg than those we have referred to, having left behind us the old Mercer County mines where nature uses her sprinklers 24 hours every day (Sundays included) and the only dust in evidence was that which trickled out of the drill hole when we boys were laboriously punching the sulphur-streaked Clarion with an antiquated "churn drill." And even that bit of actually dry dust was wetted the moment it touched the mine floor. Such, in comparison, was the mine we had gone to from the mine we had left. The field a hundred miles to the north, in which our earliest mining experience was gained, had water everywhere and dust nowhere. The first mine we entered in the Pittsburg district had dust everywhere, and a tiny pool of water was like an oasis in the Sahara. As one went in in the wagons, one remarked a cloud of fine, palpable dust floating past, and the faster the mules were driven the more the dust raised. On the roadways it lay for miles from a half inch to as much as 6 inches in the center of the rails, without any effort to remove or immunize it being made, so far as we recall. If one but went in on foot to his working place, and, something being wrong, walked out immediately, he needed the native tubbing, characteristic of the "river miner." Yet, thanks to the great dissimilarity of the conditions in some portions of this famous bed, that mine and many like it worked on complacently oblivious of such things as dust explosions. Doubtless a more modern set of mine foremen in that part of our field do better nowadays. We do not know for it has been a long time since we were there. Yet, when the same, or even better methods were tried in the deeper-lying sections of the same bed the results were tragic in the extreme, as many hundreds of widows and fatherless children in the district can attest, which is proof of our contention that no set method can be accounted of universal application. Success or failure is governed solely by conditions and not by beds.

One of the first evidences of the change in these that meets the trained eye in the newer portion of an old field is almost a complete absence of moisture in the strata directly above much of the coal in the deeper parts. One coming from mines working the same bed nearer Cannonsburg, McDonald, Carnegie, and the Lower Pools generally, as far south as Monongahela City, is particularly impressed with this fact, since in the lower end of field moisture above the coal is strongly in evidence. And all this of course has a direct bearing on the need of

* Third paper.

extreme precaution by men taking charge of either old or newly opened mines in the deeper part of the seam. The Washington and Green counties field is notably different in this respect from even the coke region, which is also an extremely soft, friable coal. So that it behooves all who contemplate opening mines in the Washington or Greene county district, to take this into consideration, since it has a vital and direct bearing on the continuous running of their mines, and freedom from disaster.

At the inception of our official career in the Washington-Green field, sprinklers were in evidence, principally in a few of the main entries. We worried in our endeavor to keep them going, a condition of things many of The Colliery Engineer readers will understand very well. Even if the sprinklers gave the results for which they were installed, to keep them in steady operation would require the services of one man to each sprayer, as they have a habit of choking up every few minutes. But granted they be kept in constant operation if left alone, the bad effect on the haulage road, especially where motors do the haulage, is well known by all who have ever resorted to this method of robbing mine air of its danger. To that difficulty is added another: finding them shut off or broken purposely or otherwise (generally the former), the motorman with lumps of rock or coal finding this an easy and subtle method of dealing with what many of these poor, self-deluded fellows—even in the most dusty and gaseous mines—consider an unmitigated and totally unnecessary nuisance.

It was at this stage of affairs we had installed what we believe was the first recording hygrometer for mine use in the United States, and gave it something to record by saturating the intake air with steam. Though hygrometer readings were taken with a portable hand hygrometer in various parts of the mine, the stationary instrument was set up near the foot of the upcast shaft at a point where practically all the air-currents from the various splits merged into a single return. This chosen spot was also near the mine foreman's underground office, where it could be observed frequently by the latter and his assistants and fire bosses, and the chart changed every 24 hours by a man especially chosen for this duty. This man's work consisted also of regulating the amount of steam injected into the mine air by means of valves placed where the main current entering the mine split into four parts. And it was surprising how often regulation was required.

Regarding this, several circumstances and conditions, natural and artificial, had definite bearings on the amount of moisture needed to keep the humidity reading at a certain figure, all of which called for close attention and intelligent service on the part of the employe chosen for that duty. And for the sake of the readers who may not understand the principle governing these changes in natural need and artificial supply we may be pardoned for explaining.

As all miners are well aware, the interior atmosphere of a mine is at all times at variance with the outside atmosphere. In summer the mine atmosphere is of lower temperature than the air outside. In winter the reverse is true, at least in those coal fields where the thermometer varies from 20 below to 100 above zero, as it does in the region where these experiences were gained. Obviously, in summer a far less amount of steam injected into the mine serves the same purpose as a larger amount in winter, because of that natural law which causes heated air to absorb and carry into the mine a greater amount of natural moisture, thus needing less by artificial means. Likewise the air then being forced into the mine, being already heated to that temperature which is part of the purpose of injected steam to do at other times, is freighted with almost its fullest possible content of vapor, and thus passes through the mine without absorbing, as it does when not preadjusted in winter, so much from the floor, sides, roof, and air. In winter, contrarily, the air forced into the mine, being of a lower temperature than that it is intended to displace, becomes heated as it travels the mine workings, and its powers of absorption are increased proportionately. Thus does it dry up thousands of gallons of much needed mine moisture and carry it outside, depriving the air constantly of the chief essential of safety. When such as that is going on, to keep the mine in a safe condition the excess of absorption must obviously be met by an excess of artificial humidity by some method. This great and vital fact ignored has undoubtedly been the cause of some of the terrible disasters of recent years, which occurred generally at that period of low temperatures when the lack of previous adjustment of the air entering the mine causes a proportionate loss of moisture.

It has been stated that in all mines east of the Rocky Mountains a certain extra amount of humidity will be found in the mine air as it nears the outside atmosphere on the return current, regardless of the state of the air entering the mine, thus robbing the mine of that much. Speaking from personal experience, a recording hygrometer set up at a point near the outside will show and record a decided drop or rise in humidity in less than an hour, when the latter is due to atmospheric changes on the surface. And these are contingencies which must at all times be closely watched by mine officials in charge of dusty mines. For unless a drop of say 10 per cent. in humidity of the outside air can be met by an artificial increase of moisture, that mine, if an extensive one, is going to lose thousands of gallons of water during the low humidity period without the trouble of pumping it! And in many mines where the danger line is always traveled pretty closely, such a condition is liable to occur very suddenly and may mean the difference between

absolute safety and positive danger, unless properly counterbalanced.

The method advocated particularly when the mine is arranged to allow the mine foreman to have an adequate amount of steam at his disposal, has the additional advantage of the quickest possible change from low to medium or high humidity, thus more rapidly than by any other agency we are familiar with, counteracting the dangerous effects arising from surface or underground causes.

So much has been written, so many theories advanced, that it is not to be wondered at if the mine official who has not tried them all out to his own satisfaction, should be at a loss which one to accept for his own practice. These papers have been written to give to others having charge of dangerously dusty and gaseous mines the benefit of that experience which, after seeking among them all, came ultimately to the use of live and exhaust steam and the recording hygrometer, as the best for the specific conditions with which we had to deal. True, some of these promulgated theories were on the face of them impossible, at least for our needs, yet a method which might not be generally useful in the Pittsburg seam, might be the best available means in some other field. The mine manager will consider all the contingent conditions and profit by them rather than be hampered. And considering the many enticing theories being advanced, the mine official does certainly need a mind of his own, if he is to steer clear of a dust or gas explosion. Nor would it be surprising to find a man so bewildered by the theoretical maze, that he had failed to assure himself as yet whether to stop the fan at firing time, pour a blanket of fine stone powder over the coal dust, sprinkle rooms, headings, and gobs as far as he could reach by water lines or wagons, or keep the dust and air moist by our own humble, although not entirely original, method. More could be forgiven a man who dallied too long in this respect than another stubborn in the disbelief in the possibility of coal dust furnishing all the necessary elements for an explosion except the initial flame; for while the former is, except in certain individual cases, not entirely settled yet, the latter has been proved beyond the possibility of a doubt. And while the former must of course vary as do conditions and individual preferences, no set rule serving as a universal panacea for this great ill, yet the fact of coal dust's explosive qualities is the same, with slight modifications, at all mines where it exists, all other essential circumstances being primed for the set-off. Hence, if he be wise, the manager who is still in doubt will at least carry out certain actions while he waits. He will clean up as much of the coal dust as is possible, and keep the mine floor and sides as clear of it as he can. He will look well to the matter of shooting, and keeping all places where a pocket of gas might possibly engender an initial flame, diluted and cleaned out. He will admit this, even if he cannot be convinced that the air, as well as the mine floor and entry sides, needs humidifying, or if he be one of those who have an idea that the injection of steam will produce an abnormal crop of falls, which in most mines, with only an ordinarily fair roof, it will not do, or at most an insignificant sum will suffice to clear away all that it creates above normal.

Naturally all these objections come up for settlement before the manager of a large mine commits himself to the one method as best suited to his needs. They did not escape us when attempting our self-imposed evolution from the sprinkler to steam moistening. We considered (without much partiality we must confess) the stoppage or reduction of air at firing time, and even the stone-dust method. For we admit there may be mines in the United States where adobe or other non-combustible dust may prove the best solution in actual practice, while not having much to its credit in theory. And it hasn't, so far as our personal knowledge goes, been sufficiently tested in mining practice either here or in Europe to merit either wholesale approval or disapproval. Certain it is that the results where it has been tried in the United States have been far from encouraging. We admit that in the matter of not wetting the haulage roads it has some advantage over any other method, but as to keeping it up to top-notch efficiency, the effort which would be required reminds us of the Irishman who was playing the fake corpse at a fake funeral. All went well until he glimpsed a considerable quantity of good Irish whisky being distributed among the fake mourners. It was at this point the "corpse" got up to remark that they'd just have to keep him drunk if they desired to keep him dead. Likewise you've just got to keep a mine wet to keep it safe. But unless the Colorado mines, and those in other arid regions where the stone-dust method has been tried, differ vastly from most of the dusty mines within 75 miles of Pittsburg, we do not see why one would not have to keep the mine constantly stone-dusted to keep it safe. And the effort and expense of accomplishing this would certainly be an enormous task, if not impossible, in mines where the undercutting employs a score or more of machines and there are several hundred loaders, where the whole day long explosive dust is being thrown in suspension in such quantities that one cannot see a light 20 feet away. It can readily be imagined what a condition the stone dust applied on Monday would be in on Saturday, particularly in the innumerable gob spaces, on extensive falls, and elsewhere in a large mine where air-floated coal dust is constantly settling. Of course it would be possible to cover, and keep covered, every foot of space even in a mine as large as Ellsworth, Vesta, or Marianna with stone dust, but the application would have to be made every day. The utter impractica-

bility appears at once to any one who knows the conditions which would have to be overcome. But the thought occurs (very pertinently to an article of this type) when one reads such papers as one recently from the pen of a Mr. Dean, advocating the stone dust as opposed to steam moistening.

In a small pick mine, where no water is available, and all power is furnished by mule and man, and where adobe or other dust is plentiful, stone dusting would doubtless be the better plan of combating this destructive element. But when one makes the assertion universal he is certainly not conversant with some of our great machine-run mines. Furthermore, when the same writer asserts that "many of the mines which have blown up in the last 18 months were water treated," the question arises as to how much were the mines which blew up water treated? We have in mind a certain operation that employed so many men it required 20 drivers to haul the coal, and it was a decidedly dusty mine. Yet one man and one mule and a water box fulfilled, apparently to the satisfaction of all concerned, the wetting process at night with water obtained from a couple of wet entries, thus killing two birds with one stone. That mine hasn't blown up yet, although as our contemporary says, it is one of the "water treated" ones which have an occasional bad habit of so doing; but the Pittsburg papers may be expected out any morning with 2-inch red scareheads concerning it. Moreover, we would distinctly impress one vital fact on the reader, contrary as it is to some of the theories promulgated by a certain school of writers, and it is that if a mine be saturated continuously by some artificial agent, as steam or water, to the extent of showing moisture on the roof, floor, sides, and throughout the gob spaces not closed in by caves, and which is possible only in actual practice in a large mine by vapor which is carried and deposited wherever the air-current itself goes, and in sufficient quantities that dust in suspension immediately becomes moist and falls, because of its increased weight, to the floor, and where even in the cold dry-air days of mid-winter the whole interior of the mine seems to be undergoing a sweating process, and all the fine dust which has fallen from cars in transit toward the surface becomes plastic and incapable of suspension by even the strongest air-current—which is a condition we have actually proved can be attained without any harm to the men or mine to speak of—we say that if an explosion occur in that mine we would be of the same opinion as the old River Pit boss as regards the Experimental Mine at Bruceton: that "there was something else in that mine besides dust."

Wet traveling ways do not always imply that a mine is safe from a dust explosion, any more than a house is proof against fire because it happens to have water in the cellar. Some of the dustiest mines we have ever seen in the general working places required gum boots to be worn on the traveling ways and haulage roads. And we believe it has been conclusively proved that an air-current passing through wet entries may still be of low humidity. There are many mines today running close to the danger line with an official complacency engendered unfortunately by this very circumstance.

Nor may the foreman lose sight of another vital fact: that even with his air robbed of all danger concerning the dust, safety cannot be assumed on one man's testimony regarding the amount of inflammable gas in the return air-current. We believe one of the most important things for the manager to know at all times is the accurate percentage of firedamp in his return air-current. That this can be attested only by the most careful examination, the following instance will suffice to show: Four fire bosses were employed in a certain mine. One had a particularly gassy section; the others fared better in this respect. The former reported one morning to the foreman that while his section was pretty much as usual insofar as the number of places showing an outflow of gas, yet he had "imagined" his lamp had shown a faint "cap" on the main air-current where, by the way, 20,000 feet per minute was passing. The foreman decided that his subordinate had really "imagined" this dangerous state of affairs, but to be sure of the matter, being a careful man himself, he had the other three fire bosses make a test in the same place, also the assistant foreman, making six men in all. And in order to have absolutely individual opinions he requested each one to examine and report to him in writing without comment to his companions as to his finding. The reports ranged from "A slight trace" to "One and one-half per cent." The foreman took samples of the air and sent to the Bureau of Mines, and the official analysis showed $^{5}/_{100}$ of 1 per cent. of marsh gas.

All of which shows that after all is said, this question, which involves the lives of thousands of men every working day, for a proper solution must largely depend on the careful judgment of the man in charge. As a rule the owners leave it to him to decide what method shall be taken to rid the mine of these dangerous elements. And with the fearful examples before us, and the knowledge free to any who seek it, no man in charge of a gaseous or dusty mine should take chances, nor need he do so. The average mine official will agree that with proper saturation either by water or vapor, it is possible to remove all the explosiveness from the coal dust of a mine. For when the powdered coal on floor and sides and in suspension is freighted with moisture to the extent of becoming plastic it has no longer the properties of, nor can it really be called "dust," any more than it can be called "mud." And with it in that condition that mine is reasonably safe so far as a "dust explosion" is concerned.

The Issaquah Coal Mine

A Description of the Coal Beds, Mining Methods, and the Modern and Complete Plant for Sizing and Cleaning the Coal

By George Watkin Evans*

THE Issaquah coal mines owned by the Superior Coal Mining Co., Ltd., are at Issaquah, Washington, a pretty little coal mining village, about 3 miles from the south end of Lake Sammanish. By rail the town is 52 miles from Seattle, but in an air line only 14 miles. Issaquah Creek, a clear mountain stream, passes through the town, and empties into Lake Sammanish. The Issaquah valley, though small, is very fertile, is an ideal location for homes, and will be connected with Seattle by a good automobile road and ferry.

The elevations on the property range from 100 to 1,000 feet above sea level. The principal topographic features of this country are the comparatively high hills that extend from near the shore of Lake Washington, easterly and northeasterly. These hills have an igneous rock base that underlies the coal measures. Low ridges of sedimentary rock extend northward from this range of igneous hills and in these sedimentary ridges the coal beds occur.

Geology.—The coal measures on this property are Eocene and over 1,500 feet in thickness, and as shown on the map, Fig. 1, they rest on igneous rock which forms Squak and Issaquah mountains. The coal beds dip northwards at angles varying from 27° to 31°. So far, ten coal beds have been discovered within this property, and as there are twelve beds in the same section to the westward, it is probable that two additional beds will be found. The beds range in thickness from 3 feet of coal and bone to 16½ feet of coal, bone, and shale. The beds worked by the former companies operating this property were numbers 0, 1, 2, 4, 5, and 6. The greater portion of the work was done on bed No. 4, which, no doubt, is the best bed on the property. In the early development of this property, under a former company, an underground channel was encountered below the bed of Issaquah Creek, and as a result, the mines filled with water. After several unsuccessful attempts to pump them out they were abandoned. The present company took over the holdings of the former company about 2 years ago, and acquired some additional land, so that now it has in all 1,560 acres of coal land.

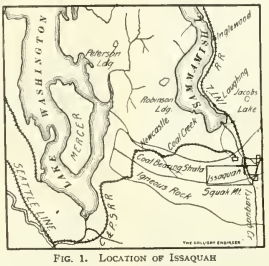


FIG. 1. LOCATION OF ISSAQUAH

The coal bed on which most of the work is now being done is called the Alvensleben bed, which was discovered on the property by the new management and named in honor of Alvo von Alvensleben, the president of the new company. This bed is 11½ feet between walls; contains over 6 feet of coal, but has several partings of clay and one parting of shale. At present one of the upper benches of bone is left as a roof. This coal bed unquestionably represents the lower split of the Bagley seam as it occurs at Newcastle to the westward.

The other seam worked is the No. 5 of this series, and is a little less than 5 feet between walls, with two clay partings. Both walls of this seam are good.

Another seam discovered on the property, locally called the "Muldoon," is above the Bagley or Alvensleben seam, and no doubt represents the upper split of the Bagley seam, mined at Newcastle; however, it is so impure that little work is being done on it at present.

The coal in these beds is classed as subbituminous. The analyses vary as follows:

	Per Cent.
Moisture	6 to 10
Volatile matter	from 30 to 37
Fixed carbon	from 40 to 50
Ash	from 8 to 16
Sulphur	from 4 to 1.5

B. T. U.'s range from 10,660 to 11,540

The coal is marketed principally in the cities of the Northwest, where it is used mostly as a domestic fuel.

The Method of Mining.—A breast-and-pillar system of mining is used in working the Alvensleben seam. Chutes 8 feet in width are driven from the gangway on the pitch at intervals of 50 feet. These chutes are carried 8 feet in width for 40 feet from the gangway, where a 6-foot cross-cut is driven to the next chute outside. Above the cross-cut the chute is continued 8 feet in width for 15 feet. A diagonal skip is then taken to the right or inside, and the breast widened to 25 feet. The next cross-cut is driven through the pillar 40 feet above the first cross-cut, and the next breakthrough is driven 30 feet above the second, then 40-foot centers from there on up for this particular breast. In the next breast inside, a 40-foot interval is left between the second and third cross-cuts and in this manner the cross-cuts are staggered to facilitate ventilation. The distance between gangways on the dip of the seam, is usually between 300 and 400 feet.

The Alvensleben seam is at present mined with a Sullivan post machine as shown in Fig. 9, where a parting 2 feet from the bottom is cut 8 feet deep in the center of the room, although the depth of the cut is increased to 10 feet at each side. A 6-foot hole is then drilled in the bottom and top on both sides, and

*Consulting Coal Mining Engineer, Seattle.

one stick of 20-per-cent. explosive is used in each hole. By this method two men with one machine can mine 16 cars of coal per day.

The coal is chuted to the main gangway, where it is loaded into cars having a capacity of 1¼ tons. The loaded cars are hauled to the bunker level by means of Baldwin-Westinghouse electric locomotives. The trolley wire carries 220 volts. The locomotive is uncoupled from the trip, outside of the main haulageway, and the cars run to the rotary dump by gravity. Before reaching the rotary dump, however, they pass over a Fairbanks-Morse tipple scale, where they are weighed. The rotary dump has a capacity of four cars per minute. After a car is dumped and brought to its normal position, the next car coming down the 3-per-cent. grade from the scales bumps it off the dump, and starts it moving down the 11-per-cent. incline to a switchback, which sends it to the foot of the empty car haul. This car haul, shown in Fig. 3, raises the car 17 feet above the loaded-car grade from which point it runs by gravity on a grade of 1.4 per cent., toward the entrance of the main haulageway to the mine, as shown in Fig. 6. The empty trips for the mine are made up at this point.

A large hopper underneath the rotary dump is so arranged that rock can be by-passed from the mine car directly into the refuse bin. When coal is dumped, it is fed on to a double-deck shaking screen by means of a reciprocating feeder, which regulates the flow.

In arranging the shaking screens, considerable variation in products was considered. The upper screen is arranged with 3½-inch perforations, and the lower screen with 2¼-inch perforations. The coal passing over the upper screen goes to a moving picking table, shown in Fig. 8, from which it is picked and chuted to a coal crusher from which it is allowed to gravitate to a dirty coal storage bin. After the coal is freed from rock it is carried by the picking table to a loading boom, at right angles to the picking table which delivers it into the railroad car. The boom is adjustable and so regulated that there is scarcely any breakage of lump coal.

The coal which falls through the 3½-inch holes, but not through the holes in the lower screen, goes to a picking table similar to the one described and the refuse is passed through a crusher. At the lower end of this picking table the coal can be loaded directly into the coal cars and mixed with the lump coal along the regular loading boom, or it can be by-passed and loaded directly into the railroad cars on another track. All the coal which falls through the lower screen passes through a chute to a 500-ton dirty coal storage bin, which serves the washing plant. If it is desired to produce a washed egg coal, the lower shaking screen can be removed and plates with 3-inch holes placed in the upper screen frame, thereby producing a lump coal from 3 inches upward and that which passes through the screen goes on through the washer; then the elevator which receives the coal from the storage bin on the lower horizontal run, elevates the coal vertically, 52 feet, and turns again horizontally where it delivers the coal onto a Parrish screen, which is used as a sizing device preparatory to putting it through the washer. The Parrish screen is arranged with ¾-inch perforations for the purpose of sizing into pea and nut coal. The coal which falls through the ¾-inch screen is washed by means of a Foust jig, after which it is classified as "pea" and "buckwheat" coal. A Shannon jig takes the coal which passes over the ¾-inch Parrish screen, and cleans and classifies it into "nut" and "egg" sizes. A chain passing from the jig eccentrics over a pulley to the gates of the storage bins insures a constant feed to the jigs. A Luhrig elevator takes the refuse from the Shannon jig, to a conveyer which elevates it to the refuse bin. The washed coal from the Shannon jig, is delivered to a double-deck Parrish screen by means of another Luhrig elevator. The upper screen, with 2-inch perforations is used only when washed egg from 2 to 3 inches is desired. This coal goes from the screen by means of a short flight conveyer to the bins for delivery into the railroad cars, or it might be by-passed to the loading boom and mixed with the lump coal if desired. When egg coal is produced at the dirty coal shaking screen and is not washed, the upper deck is removed and only nut coal is produced; the fine coal which passes through the lower or ¾-inch screen is sluiced to the head of the Foust jig for rewashing. A long-flight conveyer delivers the coal which passes over the lower screen, to bins over the railroad track, and the coal is taken to the storage bins by means of distributing conveyers. The three-compartment Foust jigs are capable of performing excellent classification and cleaning. They wash all the coal which passes through the ¾-inch screens. The washed coal is then sluiced into a large storage tank, and from there elevated to a double-deck screen, having ¼-inch perforations and all passing over it is delivered to a flight conveyer and carried into bins over track No. 1. This product, "pea coal," ranges from ¼ inch to ¾ inch in diameter. The lower deck of the screen has ⅛-inch perforations and the coal passing over it, is delivered by a plate extension into the storage bin over track No. 1. This product is "buckwheat coal," and ranges from ⅛ inch to ¼ inch. The coal which passes through the ⅛-inch screen is delivered by a sluice to the refuse heap, where it is wasted for the time being.

The refuse from the picking tables and washers, is conveyed into refuse bins, from which it is loaded into a car and hauled to the refuse dump.

There are 28 washed coal storage bins of 50 tons each, arranged in two lines over tracks No. 1 and 2.

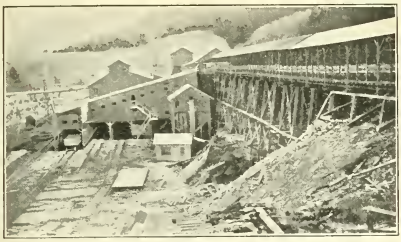


Fig. 2. Issaquah Plant from North

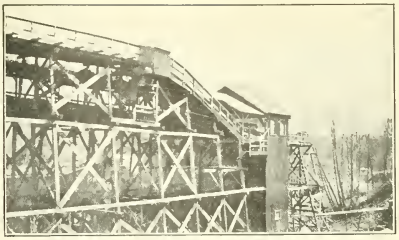


Fig. 3. Car Haul and Empty-Car Track

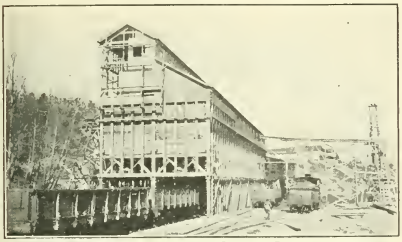


Fig. 4. South End of Issaquah Plant

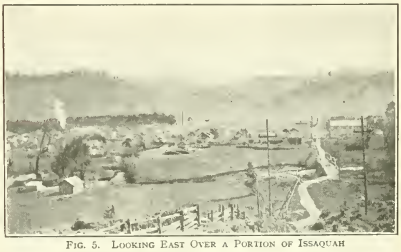


Fig. 5. Looking East Over a Portion of Issaquah

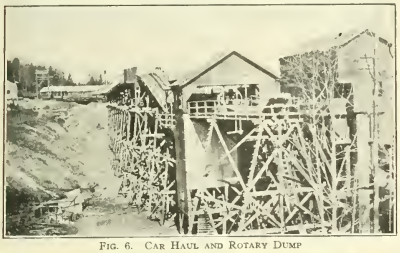


Fig. 6. Car Haul and Rotary Dump

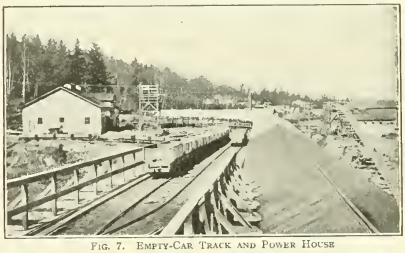


Fig. 7. Empty-Car Track and Power House

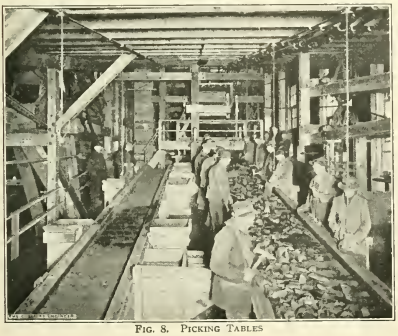


Fig. 8. Picking Tables

Fig. 9. Undercutting in Alvensleben Seam

The coal is distributed to them by means of flight conveyers. All the bins are equipped with Humphrey ladders and chutes, for the purpose of reducing the breakage of coal as much as possible.

Good head room is arranged throughout the entire plant, and the pulleys and belts are well guarded. The plant requires 60,000 gallons of water to fill the recovery tanks and jigs. This is supplied by a 3-inch, direct-connected, motor-driven, centrifugal pump, located on the creek bank. Once the plant is in operation, 200 gallons of fresh water per minute are added to the circulating water system, to allow for the proper degree of cleanliness. The fresh water is applied above each Parrish screen, where sprays thoroughly rinse the coal before it passes into the storage bins.

Power and Power Plant.—The electric power, furnished by the Puget Sound Traction, Light, and Power Co., is delivered at the Issaquah company's substation at 2,200 volts, three-phase, 60 cycle. When the plant is in operation, it requires approximately, 1,200 horsepower. The current is received and distributed through an 8-panel switchboard. Panel No. 1 is a main totalizing panel upon which is mounted an automatic oil circuit breaker, indicating and integrating watt meters, three ammeters, and voltmeter. Panel No. 2 controls the 300-horsepower synchronous motor driving the air compressor and is equipped with one ammeter, indicator, automatic oil switch, etc. Panel No. 3 controls the 2,300-volt feeder circuit leading to the upper workings of the mines. Panel No. 4 controls three 100-kilowatt, 2,200-volt primary, 220 volts secondary transformers, for furnishing the low-tension current for the washing plant. Panel No. 5 controls a 150-horsepower motor-generator set. Panel No. 6 controls the 100-kilowatt railway generator. Panels Nos. 7 and 8 distribute 220 volts current from the three 100-kilowatt transformers to the washing plant.

The central power distributing station and compressor house is 48 ft. × 60 ft., and is built near the entrance to the main haulageway. In it is one 23¼ and 14¼ × 18 duplex, direct-connected, motor-driven, Ingersoll-Rand air compressor which furnishes air for the mining machines used in the mines. It has a piston displacement of 1,613 cubic feet of air per minute with an actual guaranteed capacity of 1,380 cubic feet, or an efficiency of 85 per cent. The two 8-ton Westinghouse electric locomotives used in the mine, are supplied with direct current generated by the 100-kilowatt Westinghouse motor.

The Issaquah plant was installed by the Link-Belt Co., of Chicago. Robert M. Hale, consulting mechanical engineer, of Seattle, supervised the erection of the plant in the interests of the coal company. The writer is under obligation to Mr. Hale for information in connection with this article. The electrical equipment was installed by W. R. Hendrey & Co., of Seattle, and is a fine installation in every particular. This plant has created considerable interest in the Northwest coal mining centers, for the reason that it is the first modern coal washing plant to be designed in this part of the country. Mr. Walter Baelz, a German mining engineer, is general manager of the property, and has been responsible for the arrangement of the present mine.

Should the market require it, this plant could produce 1,000 tons of coal per day of 8 hours, and is designed on the basis of such a production.

International Engineering Congress, 1915

The attention of the engineers of the world is being more and more drawn to the program of the International Engineering Congress, which is to be held in San Francisco, California, in 1915. The interest which has been aroused in foreign countries is shown by the fact that at the present time there have been received enrolments and subscriptions from 42 such countries.

Full information concerning the Congress may be obtained by addressing the Committee of Management, International Engineering Congress, 1915, Foxcroft Building, San Francisco, Calif., U. S. A.

Bridges or Brains?

Centuries ago, a river flowed from the mountains of northern China to the sea. Although the river was not deep, the current ran swiftly, and coolies carrying heavy burdens could not ford it. So the Chinese built bridges across it—queer, humpbacked stone bridges such as you will see pictured on "willow" plates; and over these the coolies crossed in safety.

As time passed, the river, never very deep, began gradually to dry up. It grew steadily shallower, and the current ran less swiftly than before. But still the coolies used the bridges. Their ancestors had used them, and it never occurred to any one to do otherwise.

Today, where once a swift river flowed, there is but a shallow, dusty ditch, down the middle of which occasionally trickles a sluggish thread of water. But still the coolies toil with their heavy loads over the steep, crumbling stone bridges. They might save time and energy by going straight across the river bed, over which they now could pass dry shod. Yet no one of them ever does. The thing has never been done, they will tell you; men have always crossed by the bridges.

Are you using a bridge instead of your brain? The mere fact that you are accustomed to do a certain thing in a certain way is no proof that you or the company have found the best or the quickest way.

Conditions change, and methods must keep pace with them. Don't become an automaton. Try and find quicker, more direct means of solving your daily problems.—*Western Electric News.*

The Somerset Mine

Of The Utah Fuel Co.—An Example of a Well Planned and Carefully Managed Coal Mine Plant

*By B. P. Manley**

THE Utah Fuel Co.'s Somerset mine is on the north fork of the Gunnison River, Gunnison County, Colo., at the base of Fire Mountain, and is reached by a branch of the Denver & Rio Grande Railway, from Delta, Colo. This property, for progressive and consistent operation has few equals in the Western States, and few superiors in the more eastern states.

Fig. 1. Reinforced Concrete Mine Portal

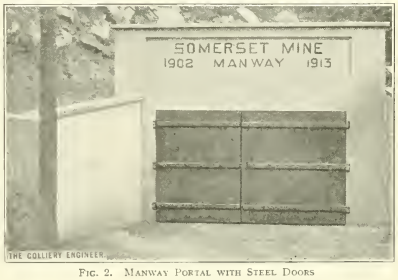


Fig. 2. Manway Portal with Steel Doors

The mine is situated at an elevation of 6,050 feet above sea level, in the Somerset group of the Book Cliff coal field (Laramie Series).

The coal is bituminous, 16 feet in thickness, declines toward the northeast at an angle of 3° 30″; and has well-defined cleatage varying in width from 3 to 12 inches.

In the system of room-and-pillar mining adopted, the work is advanced in a direction that takes into consideration the butts and faces, and the rooms are driven almost at right angles to the line of cleatage, which permits the coal to be worked to greater advantage than would any other direction.

Coal mining is aided greatly by the movement of overlying strata which causes the opening of cleavage to such an extent that only small quantities of powder are required to separate the coal from the ribs or "tight" side of room. A permissible explosive has been adopted for use throughout the mine.

Ventilation is induced by an 18′ × 5′ double-inlet reversible Jeffrey fan, having a rated capacity of 300,000 cubic feet of air per minute at a pressure equivalent to 6 inches of water gauge. The actual delivery of the fan running at a speed of 110 revolutions per minute and a pressure of 3 inches water gauge, is 225,000 cubic feet per minute, which shows conclusively that frictional resistances to air-currents have been reduced to a minimum.

The mine is ventilated by a series of nine splits, each split receiving its quota of fresh air from one of the intake air-currents, and passing through to all the working faces. Working faces, in this instance, means all rooms and entries, and not, as in many cases, a fair air-current traversing the main haulage or airways, and the face of rooms and headings destitute of any moving air. The writer finds pleasure in stating that an ample amount of pure air was conducted to the face of each working place by means of brattice constructed of fireproof material.

All air stops are constructed of rock or concrete. The main slope and airway walls are 2 feet in thickness, and in levels concrete walls 6 inches in thickness are erected. All overcasts are built of concrete arched and reinforced with rails, old wire rope, and scrap iron. The vertical walls are built 18 inches in thickness, while the thickness of the arch decreases from 11 inches at the side wall to 7 inches in the center. A unique way of bending the rails, used for reinforcing the arch, to the desired curve, is employed at this mine, and attention is called to the method, as by its use much time and labor can be conserved.

The rails, generally about 12 in number, dependent upon the width of overcast, after first being secured together side by side, are suspended by the ends over a fire; the height at which the ends are suspended conforms to middle ordinate of the desired arch. As soon as the rails become hot they begin to sag at the center, the weight of the rails being responsible for this. At regular intervals additional supports are placed in order to make the sag of the rails regular and in conformity with the desired curvature. By this method an excellent reinforcement for the arch may be secured at a cost of not to exceed $20; whereas, with the blacksmiths and helpers required to heat and bend rails over an anvil or form, a much greater

*Mining Engineer, Salt Lake City, Utah.

cost would result and generally much more irregularity in curvature. Fig. 3 shows one of the overcasts in use at this mine; all are of similar construction, are fireproof, and cover an area of from 80 to 90 square feet. The average cost of erecting such structures is $316.87, exclusive of roof brushing, which is not an exorbitant price for such efficient structures.

The employment of overcasts renders the use of doors unnecessary, and as a consequence, all haulageways are unencumbered with such appliances. In the traveling ways it becomes necessary to install doors in order to allow air-currents to travel in their regular channels, and wherever they become necessary, the doors are built of No. 8 steel, reinforced at the perimeter with 2-inch angle iron. The door frames are of reinforced concrete with 2-inch angle irons built into the frame to act as jambs. Wherever it becomes necessary, at least two doors and in some cases three doors are erected for the purpose of providing airlocks, thus an air-current would be always undisturbed, the doors being placed at sufficient distances apart to allow persons to be well between the doors when opening and closing.

Fig. 7 shows the method of rendering pump houses fireproof; the walls, floors, and roof, being covered with reinforced concrete. All electric wiring is placed in conduits about such pump houses, and seemingly no possible chance for fire remains. The cost of such pump houses including excavation, labor, and material used does not exceed $350. Is it not worth such outlay to eliminate the probability of mine fires in electrically operated pump stations? When one considers the dangers from the careless wiring so often affected about underground installations, with the wires of indifferent insulation often conducted through wooden conduits, frequently trailing over a damp floor, often tied to timbers with wire, is it not worth noting how these chances may be eliminated at comparatively small cost? It is such attention to details for eliminating much of the visible hazard of mining that makes for progressive and consistent operation.

The combating of dust, one of the great menaces to mining operations, is accomplished in a manner that is probably the most original and effective method in practice, at least through the Western States.

The water supply for sprinkling is obtained by the use of mine pumps, which provide from mine sources approximately 225,000 gallons per day. This water is placed directly into sprinkling lines at all levels, by the use of one 3-inch two-stage, electrically operated turbine, and one 4-inch four-stage turbine.

Branch pipe lines are connected into the main discharge line at each level, and conducted their entire length; three-quarter-inch pipe lines are conducted into the face of every working place, and each miner is provided with a hose line and bibbs. The miner is required to keep his place wet; so strictly is the rule enforced that should his working place not be found in a state of saturation, his immediate discharge is the penalty. It becomes seldom necessary to censure for such neglect; the miner realizes that the harmful dust must not be found floating in the atmosphere wherein he must breathe and work, and as a consequence before taking down coal from the face, which in falling would generally cause a cloud of dust to be suspended in the atmosphere, he leaves the working face and turns on the water, which is always at full pressure, and thoroughly waters the walls and floors of the working place. The writer noted in many instances where this course was pursued before and after the fall of coal was made. In addition to caring for the immediate working faces, a corps of men are engaged in sprinkling all haulageways and the outer part of the working rooms; all traveling ways, and disused workings are thoroughly cared for in this manner, thus a condition of complete saturation maintains throughout the mine.

Now, at first the reader may be inclined to consider that such a system may be costly to install and maintain, yet the cost of installing pipe lines, including labor and material, together with cost of labor of sprinkling corps and pipe line repairs, proves not to exceed $.02 per ton.

In addition to the feature of safety provided by the desirable condition of humidity obtained, does not

Fig. 3. Concrete Overcast on Main Haulageway

Fig. 4. Overcast at Side Track in Level

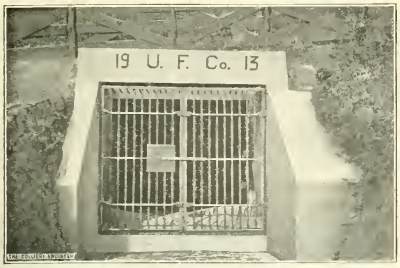


Fig. 5. Emergency Traveling Way. Gates May Be Opened from Inside at All Times, But Not from Outside

Fig. 6. The Mules and Their Drivers—An Important Part of the Haulage System at Somerset Mine

the suggestion present itself to the reader that the having all of the mine piped and those pipes containing water under pressure at all times, would be of inexpressible value in the event of underground fires, when it is taken into consideration that in every part of the mine a hose connection is established at a distance not to exceed 75 feet. How different from the condition in so many mines, where, after being apprised of fire, it becomes first necessary to "rustle" the pipe, and then proceed to lay several hundred feet of it through a smoke-infested area. Consider that this obnoxious condition may be eliminated and the mine kept in a desirable state of humidity, for 2 cents per ton.

The matter of pipe lines suggests the attention that is given to pipe lines in use. It was noted that along the entries pipe racks were built, merely props with 2″ × 4″ cross-arms, and upon these cross-arms the pipes were stored, awaiting the needs of the pipemen. An item! Yes, maybe a small matter, yet in how many mines as one passes along the entries the ends of various sized pipes are seen protruding from a pile of shale or gob, allowed to remain there, rusted, dented, valueless.

This matter of caring for pipe may not be one of the essential features of mining operations, but he who neglects such details is not securing all the values from all expenditures. When a pipe line has been in use and the district wherein it was used ceases to operate, the pipe is taken to the surface, straightened upon a wooden block by means of a wooden mallet, the rust and scales removed by the same action, and then is dipped into a bath of tar, and placed upon a rack in its serial sizes for disposition.

Care of Haulageways.—It was a noteworthy fact that at no time or place along any haulageway was gob or refuse matter allowed to accumulate.

The main slope haulageway is kept clean from wall to wall, the track being ballasted with cinder refuse from the boiler house, this provides an even, regular surface, free from water holes and depressions. The main haulageway, being whitewashed, presents a clean and wholesome appearance, and would instantly show the accumulation of dust, should such occur. The whitewash was placed with a spray pump, and cost $.668 per 1,000 square feet. The slope is lighted with incandescent lamps its entire length.

The level haulageways are kept thoroughly clean, no accumulation of gob is permitted upon roadsides nor in cross-cuts. One may walk comfortably between the track and coal wall without interruption; this feature makes for greater safety, inasmuch as the matter usually found along roadways, carries a goodly quantity of coal dust which under some conditions aids in extending explosions.

The cleaning done upon haulageways is such as many operators would do well to pattern after. How much litigation could have been avoided as a result of accidents, often directly attributed to unclean and consequently unsafe haulageways.

Mine Development.—This feature of operations has been carried forward with a view to large production. The working places available for operations represent a production of 2,400 tons daily, and, in addition, sufficient narrow work has been driven to provide ample development for another 1,000 tons daily, thus the capacity of the mine at this writing is conservatively 3,400 tons per day.

In all advance work an average thickness of 3 feet of coal is left for roof support, and in consequence only a small amount of timber is required to be placed upon haulageways. This roof coal does not yield readily to pressure, and entries may be driven to an indeterminate distance without fear of caving or breaking roof, a condition that favors carrying forward development work without the necessity of clearing up extensive rock falls when productive operation begins, thus all advance work at this property proves a valuable asset instead of a source of needless expenditure, particularly since a fluctuating market may cause the demand of production to vary from a few hundred tons daily to several times that amount. By this new method of development any reasonable exigency that may arise may be met without later injury to the property.

Steel Rails For Roof Support.—A valuable use for old steel rails, is exemplified in the main airways and the haulage roads. These rails are cut to the proper length and to each end of the collar are riveted angle irons, that are later bolted to the rails which form the legs, when put in place.

These rails are generally the discard from the railroad company, and are purchased at a nominal figure. When erected in the manner stated they make excellent roof supports which outlast any timber possible to procure and are rapidly replacing the old wooden sets which are generally in use for such purposes. The life of ordinary timber sets is 18 months, cost $6.91 per set; steel timber costs $9.81 per set.

First-aid stations to the number of 12 have been installed underground, each equipped with splints, bandages, oils, stretchers, blankets, etc. Posted at each of these stations are some pointed remarks as to what to do for various injuries. Much interest is evinced in this branch of work by both officials and miners, a large percentage of whom are conversant with the methods of caring for injured persons. Instruction classes are held regularly under the personal supervision of the resident physician, to whom for careful and thorough training in first-aid work the employes are greatly indebted.

Traveling Ways.—To avoid the necessity of miners traveling upon haulageways, roadways for their use are driven abreast of all advancing main roads so that at all times the miner is securely protected in this regard. These traveling ways, lighted with electricity, are kept in an inviting condition, so that the miner prefers to use them in preference to the haulageways. Sign boards are placed at each turn of the road, bearing an index finger pointing the way out, here also ample lighting arrangements are provided. The floor is kept free from water and cumulative matter, depressions are filled with cinders, and thus walking is rendered much easier than upon roads where there is mechanical haulage. The location with regard to convenience of entrance from each level has been given due consideration, and as they are much more readily reached by the miner than would be a haulage road, all employes of their own volition use and travel these roadways.

Care of Haulage Roads.—A notable feature of the haulage roads is the care given to the elimination of friction; at no place do the ropes come in contact with a rigid surface, rollers are so placed that the rope is not permitted to drag upon the ground, and so well has this matter been attended that a rope having a diameter of 1 inch had up to the present writing hoisted a total of 1,109,234 tons. Only strict and regular attention to the elimination of wear would permit this. Side sheaves are erected where the rib would otherwise be encountered, rollers are not permitted to become rigid, and are kept in place.

This feature of haulage is one that is often neglected, ropes are allowed to run persistently over switch points, and rigid rollers, and as a consequence the life of the rope is greatly lessened, and frequently breakages with the attendant wreck can be attributed to such causes. All conditions are encountered here that are usual upon slope haulage systems, and it is only by thorough attention to these details that the great length of service is obtained.

Mine Inspection.—An ample number of fire bosses is provided, whose sole duties are patrolling and examining the mine. The mine is under inspection, both by day and night, fire bosses being employed to patrol and inspect all working places on successive shifts, which extend over the entire 24 hours; thus it is improbable that fires which might occur would reach any magnitude, or that gas accumulation could assume any proportion that would menace the safety of operation.

Assistant mine foremen are employed, whose duties are to examine working places to warn miners of the various dangers of their respective places, and to impress upon them the necessity of compliance with mine rules; as a consequence of this method of procedure, not a single fatal accident has to be catalogued against roof falls during the entire period of operation.

It is the duty of each succeeding shift of fire bosses to note and record at the time of commencement of shift, the number of revolutions per minute of the fan, the height of the water gauge, the temperature, and the height of the barometer, all of which instruments are installed near the fan house. Any marked change in the last named instruments is called directly to the attention of the management.

In addition to the foregoing, the fan is provided with an attendant, both day and night shift, whose sole duty it is to care for the safe operation of the fan; this provides a most thorough attempt to avoid breakdown of fan, which so often occurs when such machinery is given only indifferent attention.

The mine is equipped with telephones, connecting all sections and the surface plant, such as mine office, power house, superintendent, master mechanic, mine foreman, hospital and hoist house. This makes for consistent operation, as communication can be established at all times; material needed is telephoned for and sent below without the delay occasioned by requiring an employe to go to the surface in person for such requirements.

Maintenance of Air-Courses.—This important feature is given thorough attention throughout this property, no accumulation of gob or timber being permitted in such places. In main return airways an area of 110 square feet is maintained, sides and roof are kept free from abruptions that would cause resistance to the ventilating current. Throughout the main return airways steel rails are used for roof support instead of timber. The value of caring for airways is incomputable to any

property, except in those mines where the airways are allowed to become choked with roof falls and broken timbers until they are frequently impassable and unsafe to operate further without supplying more efficient air-currents to interior working faces; then comes the necessity of opening up old airways, the removal of debris, always a tiresome

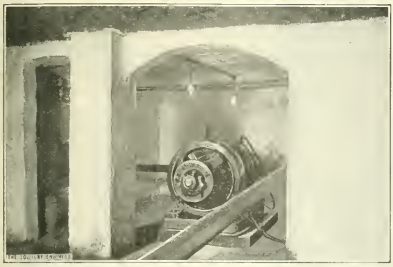


Fig. 7. Fireproof Underground Pump House, No. 1

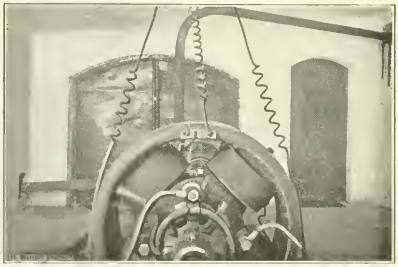


Fig. 8. Concrete Pump House No. 2

job, costly, and slow, taking frequently years to bring about results. All of this could be obviated, were more attention given to airways as the mine develops, at which time the cost is unnoticed, and easily borne. This feature is cared for in a most thorough manner throughout this property.

The Surface Plant.—The surface plant presents an appearance of cleanliness and neatness. The boiler house, wherein are installed six 150-horsepower flue and water-tube boilers, is floored with concrete, and the boiler fronts and stacks are kept painted to prevent rust.

The power house contains one 175-kilowatt, 500-volt, direct-current generator, one 75-kilowatt, 2,200-volt, alternating-current generator, one 1,100 cubic-foot air compressor, pumps, etc., all of which are kept in a remarkable state of cleanliness and brightness.

The floor of the power house is not allowed to become a repository for oil and waste, all such being cared for by drip pans and later filtered and cleaned for use again. Floors are regularly scrubbed, and

woe betide the man who ruthlessly enters without using the door mats provided.

All elevated pipe lines are thoroughly wrapped with asbestos and galvanized iron and are supported by steel posts set in concrete at the base.

The screening plant is provided with shaking screens, suspended from a four-track tipple, wherefrom an excellent preparation of coal is produced.

Stables are kept in a clean and sanitary condition, disinfectants being freely used. Both the inside and outside of the barn, together with the fences are whitewashed regularly. Feed rooms are lined with sheet metal to render them mouse-proof. No animal is permitted to work that has sustained even the slightest injury or any ailment until such condition shall be entirely remedied. Thus, the stock is in fine condition, and no sore shoulders or swelled joints and consequently no balky mules exist at this plant.

An item of interest was the attention given to renewing old valves, which at most properties are considered useless and relegated to the scrap pile.

For regrinding the seats and disks of valves a machine is provided that may be used while the valve is in place, and without disconnecting the pipe. The initial cost of the machine was $75. Taken at random from supply records, the writer finds that during a stated period of time a total of 81 valves had been ground with the machine. The initial cost of these valves, which ranged from ¾ inch to 3 inches, was $316.27, the cost of labor and supplies for repairing these 81 valves was $46.40, a saving of $269.07. All of these valves would have become scrap were not such an apparatus in use. The foregoing shows the attention to minor details which are so frequently overlooked at a great majority of coal properties. The sentiment prevails at this mine that nothing must be wasted.

The care of supplies is a feature that is often neglected and thereby a great deal of loss is sustained. At this mine the matter is given marked attention, a stone house being provided for the supplies, which are catalogued and placed in bins and upon racks, in accordance with their size and numerical order. A condition of order was established throughout the supply house, such that the writer was able, as a test of the correctness of the storing, to secure from different sections of the store house, small articles which are not generally of daily requirement, within a few moments. Usually, to locate such articles it would require the supply clerk, master mechanic, and all other available hands to "hunt" for them; not so at this plant. All material being catalogued and noted it never happens that material that is supposed to be on hand has to be ordered at the moment of its requirement for use, and some

important job has to be delayed until the material arrives. How often has this condition occurred and later the material supposed to be on hand was found covered up by a pile of cement sacks, rope or what not?

Another item was noted that bears direct relation to the general efficient methods of operation. A book of the plant is kept wherein each engine and machine, together with its number, style, price, and history is detailed. Again the various parts of machinery are catalogued, size of gears, pistons, diameter of cylinder, and all data relevant to each part of a machine are duly noted. Additional data are catalogued upon the cost of installation, foundations, transportation, etc., and these are subdivided into cost of labor and materials, all of which are of much value when considering subsequent installations.

The camp is situated upon the banks of the north fork of the Gunnison River, a stream which renders fertile, a valley of wonderful beauty, wherein is situated the towns of Hotchkiss and Paonia, famous for their fruit crops. The hills by which the valley is bounded are covered with a growth of verdure, that presents a pleasing picture. Within reasonable distance of the camp, game abounds, and as the higher waters of the river are reached, trout are found in satisfying quantities.

The miners' cottages, each of four and five rooms, are painted with varying colors; fences are built around all cottages, and trees have been planted throughout the camp. A band stand, baseball park, and dance hall are provided for the entertainment of the residents.

There is an efficient school wherein all grades are taught by a principal with an efficient corps of teachers.

A hospital where all injuries are cared for under the supervision of the camp physician is provided. The hospital contains three wards where at times of emergency 15 patients may be comfortably cared for. The operating room and dispensary are equipped in such manner as to care for all ailments usually encountered. Ample lawns surround the hospital, wherein abound flowers and shrubs, presenting a pleasing appearance, a desirable spot for convalescing patients.

OBITUARY

JAMES ANDERSEN

On March 14, James Andersen, after a lingering illness of two years, died at his home in Seattle. He was regarded as the foremost coal mining engineer on the Pacific Coast.

James Andersen

Mr. Andersen was born in the town of Ringkjobing, Denmark, 59 years ago, and studied engineering at the University of Denmark, from which he graduated at the age of 22. For 3 years he was instructor in enginering at his Alma Mater.

At the age of 25 he left Denmark and came to the United States, and at Braidwood, Ill., he became engaged in underground work, and did surveying for some of the smaller coal companies.

In 1880 he went to Colorado, where he followed quartz mining and prospecting for 2 years. He then returned to Illinois, this time to Streator, and became chief engineer of the Chicago, Wilmington, and Vermilion Coal Co., which position he held for 8 years.

In 1890 he was engaged by the White Breast Coal Co., of Ladd, Ill., where he sank several shafts; in some of which he had to contend with heavy beds of quicksand.

Later he became general superintendent of a company operating coal mines at New Castle, Colo., and vicinity. This position he held until the company sold to the C. F. & I. Co. in 1899.

On leaving Colorado, he went to the state of Washington. His first work was with the Pacific Coast Co., as examining engineer, which position he held for 2 years. In 1901 he became chief engineer of the Pacific Coast Co.'s various operations, and later general manager of the company's mines, which position he held at the time of his death.

Mr. Andersen was in many ways a remarkable man, and only those who knew him best, really appreciated his great intellectual power. He scorned publicity and regarded his achievements as a matter of course. Nature endowed him with a remarkable brain, and his mental training was such that he could retain the greatest amount of accurate detail.

When he went to Washington, Mr. Andersen began a study of the geological structure of the coal fields. He was engaged by the Pacific Coast Coal Co., to study their coal areas, and at the same time he extended his studies over other fields. His intimate knowledge of the structure of these coal fields made his services of inestimable value to his company. The coal measures of western Washington are very complex, and Mr. Anderson by his detailed study had a better knowledge of their nature than any other man on the Pacific Coast. When members of the Washington State Geological Survey were studying the coal areas of the state, he was the one to whom they went for suggestions when puzzled by some complex problem.

Mr. Andersen had the confidence of his superiors, and the admiration of his subordinates. The miners and other employes of his company had always the greatest confidence in his treatment of them. He was

always a friend of those who needed sympathy, and his sympathy frequently took practical form, known only to those who received it. In private life he was a great lover of home, and was never happier than when romping with his two children. He married Miss Julia Neilsen, in 1901, and she, with two minor children are left to mourn their loss. He was a member of Tyee Lodge, Free and Accepted Masons, of New Castle, Wash., and was also a member of Knights of Pythias of Glenwood Springs, Colo. He was a member of the Protestant Episcopal Church.

Mr. Andersen was appointed by former Governor M. E. Hay, a member of a commission to draft an Industrial Insurance Act, for the state of Washington. This bill was passed and is now in force in that state.

GEORGE F. BAER

George F. Baer, President of the Reading Company, of the Philadelphia & Reading Railway Co., of the Central Railroad of New Jersey, and the executive or a director of a number of other large corporations, died at his residence in Philadelphia, on April 26, in his seventy-second year.

Mr. Baer was a man of remarkable ability and personality, who rose through merit alone from comparative obscurity to the position of head of two great railroad systems and one of the greatest, if not the greatest, coal mining companies in the world.

He was of German ancestry, and was born in Somerset County, Pa., September 26, 1842. His ancestors came to America in 1743.

Mr. Baer received his early education in the country schools of Somerset County, and in the Somerset Academy. At the age of 13 he entered the printing office of the *Somerset Democrat*, where he worked for 2 years. After this he was a student at Franklin and Marshall College. In 1861, his brother Henry and he purchased the *Somerset Democrat*. The brothers, being strong Democrats, opposed hostilities toward the South at the outbreak of the civil war. Later, when the war was on, and the life of the nation was threatened, Henry Baer entered the Union army as an officer in Colonel Campbell's regiment, leaving his younger brother George to be typesetter, editor, and general manager of the paper. At night the young man found time to study law. In August, 1862, Mr. Baer, unable to withstand the call of his country, organized a company of volunteers, of which he was elected captain. This company was mustered into service as Company E, 133d Regiment, Pennsylvania Volunteers. During his military service he participated in the second battle of Bull Run, Chancellorsville, and Antietam. At Chancellorsville he was detailed as Adjutant-General of the Second Brigade. Upon the completion of his service he returned to Somerset County, where he resumed the study of law in the office of another brother, William J. Baer. He was admitted to the bar of Somerset County in April, 1864. In 1868, he located in Reading, Pa., where he soon won prominence as an able and trustworthy attorney. He was engaged as counsel in Berks County for the Philadelphia & Reading Railroad Co., and in 1870 was appointed general counsel. In the eighties he was elected a director of the corporation, but resigned from this position during the McLeod administration, though he was continuously retained as general counsel. In 1901, when, after years of financial difficulties, the Philadelphia & Reading companies were in process of rehabilitation, Mr. Baer was elected their president, his great ability, cool temperament, and rare good judgment having been so marked as to attract the favorable attention of the great financiers of the country.

George F. Baer

His success as the executive head of the Philadelphia & Reading companies and allied interests is best marked by the great rise in the value of their stocks and securities under his management.

Mr. Baer, as president of the corporations, was an indefatigable worker himself, and he chose as chief operating officials, men of ability having the same qualification. He knew the capacity of these men and gave them absolute control of operations, making them responsible only to him. The result was most satisfactory. His lieutenants were not only faithful to the trusts reposed in them, but were his loyal personal friends.

Mr. Baer was not a man of striking appearance, and as he never courted public attention, would be passed on the street as an ordinary well-to-do business or professional man with no apparent marked characteristics other than those of a thoughtful, reserved man. Those who knew him personally were the only ones who sounded the depth of his nature. They knew his high appreciation of all that was good and beautiful, his affectionate home life, his love of books and art, his appreciation of humor, and his devout Christian character.

As is the case with most successful men, Mr. Baer was at times misunderstood, and during the great anthracite strike of 1902, he was bitterly assailed by agitators and sen-

sational newspapers, and the import of his statements, and in fact the wording of them, was twisted to suit the ends of interested parties. Time, however, has righted to a great extent the wrong impressions then created.

Mr. Baer, as the head of a great industrial corporation, resisted certain demands of a great labor union, because he believed them unjust, and to not resist them would make him untrue to his stewardship. When the contest was settled by the award of the Commission appointed by President Roosevelt, in which Mr. Baer acquiesced, and later there was occasional intercourse between Mr. Baer and prominent labor leaders, the latter learned to respect and admire the true worth of their former antagonist.

While Mr. Baer had slightly exceeded the Biblical "threescore years and ten," he was an exceedingly active man, and his appearance gave every indication of a number of years more of activity and usefulness. He was a great man and his death is a loss to the nation.

The Aczol Process of Preserving Mine Timbers

The preservation of mine timbering is not a new subject, but one far from perfected. The aczol process of treating timber described in a recent issue of the *Colliery Guardian*, promises a new development in mining practice.

Creosote, the preservative most generally used in the past, is expensive to purchase and apply and highly inflammable. In Europe, impregnation of timber with heavy metallic salts has been practised extensively and with a considerable measure of success. The great drawback to such processes is the fact that the active salts are more or less rapidly leached out. From 35 to 60 per cent. of timber consists of cellulose and the well-known property of an ammoniacal solution of copper salts dissolving cellulose offers a very likely means of fixing preservative materials in the latter. By the use of certain metallic ammoniates in conjunction with phenols, it is possible to combine the mordant or amalgamating effect of ammoniacal copper solution on cellulose with the considerable antiseptic value of copper and zinc salts, and the much greater antiseptic and preservative value of phenol, while at the same time securing a permanence of action greater than can be obtained by any other means yet discovered. This forms the basis of the aczolling process. It is found that one-eighth of 1 per cent. of phenol is sufficient to protect gelatine (a substance much more susceptible than timber) against fungoidal growth. Whereas creosote contains but a small percentage of this active preservative, of which a yet smaller percentage is fixed permanently in creosoted timber, concentrated aczol contains over 150 times the percentage of phenol required to sterilize even gelatine, and the whole of the quantity actually injected into timber to be preserved is "fixed" indefinitely. There is, in addition, in concentrated aczol about 10 times the quantity of metallic salts required to sterilize gelatine, and since this, like the phenol, can be fixed permanently in timber, it is obvious that aczol, sold in a concentrated form for convenience of transport must be diluted very considerably before use. Actually it is found that a 1 : 5 solution of aczol in water forms a serviceable protective paint, while a 1 : 33 solution is suitable for the complete impregnation of timber. The preservative solution is used cold, and timber may simply be submerged in it for a week or ten days or the period of treatment may be reduced to a few hours by use of a simple pressure plant.

The preservative action may be thus explained. The "mordant" constituent in the thin solution injected forms a gelatinous covering on every fiber and tissue of the fiber under treatment, and the speedy disappearance of the volatile alkali solvent is followed by the formation of insoluble cellulose compounds which constitute a tough homogeneous, non-hygroscopic, and permanent protective sheathing round every fiber and tissue while, at the same time, cementing the latter together and rendering the wood waterproof, non-inflammable and considerably stronger than it was before treatment. The weight of the timber is not seriously increased by the process, and the wood is left clean and capable of being painted or even polished. No salts are introduced or can be formed in the timber, injurious to the latter or to iron or other metal work, and the preservatives themselves are unaffected by hot or cold water, by carbonic acid, sea salt, or, indeed, any natural constituent of atmosphere or soil.

Recent tests have shown that the relative compressive strength of timber treated with creosote, copper sulphate and aczol to be 1 : 1.8 : 2.0. The use of aczol reduces very considerably the percentage of props falling by crush or squeeze, and actual experience in French and Belgian collieries shows that props that lasted only 6 or 8 months untreated are perfect after 2 or 3 years service when aczolled. One colliery alone has in use 180,000 cubic feet of aczolled props.

The strength of solution employed may be proportioned to the needs of each case; generally it is unnecessary to use as much aczol as would preserve the original strength of the timber for 20 to 30 years.

From data now available, it may be taken that 4½ ounces of aczol per cubic foot will preserve timber for 10 years in circumstances under which untreated timber would become useless within the year.

The volume of the saline matter in the ocean is a little more than 4,800,000 cubic miles, or enough to cover the entire surface of the United States, exclusive of Alaska, 1.6 miles deep.

Kentucky System of Land Surveys

And Their Relation to Titles in the Mountain Section—Necessity of Thorough Knowledge of Early Customs in Locating Surveys

By W. T. Griffiths, C. E.*

THE writer offers his apology to the legal fraternity for so much of this article as may intrude on their prerogatives as abstractors, and will say that it has been drawn out by objections made by investors who would come into the country, but have been scared off by the experience of others who have been the victims of misplaced confidence in that class of attorneys who through ignorance or shiftlessness put out an abstract without an accurate map showing correct location of all "surveys" or patents and also boundary deeds.

In explanation of the term "survey," I will say that it is the legal name covering the survey, description, and plat of the same, that are filed with the Registrar of the Land Office to obtain a patent for a tract of land.

"Boundary deeds" are conveyances of land by either natural or artificial boundary lines other than "survey" or patent lines.

As an illustration of the necessity of an accurate map, the writer was shown an abstract in which the attorney showed a title from the state based on a survey made by the same man from whom this title was derived, but this survey laid 3 miles from the land in question, while the survey that did affect the land, did not cover within 100 acres the land attempted to be conveyed by a boundary deed.

In fact a correct abstract cannot be made without the joint work of the surveyor and the attorney; and the surveyor should have a good knowledge of laws applying to the restoration of lost lines and corners and the correction of defective surveys.

For the purpose of this article we will divide the surveys into three groups according to time of material changes in the law: First, Virginia grants and Kentucky surveys made under those grants. Second, Kentucky surveys made previous to 1890, up to which time there was no limit to the amount of land that could be embraced in one survey. Third, after 1890 there was a limit of 200 acres.

And into three classes as shown by the motives of the parties having the surveys made.

But before going further we wish to call the attention of the reader to the difference between the system of surveys in eastern Kentucky and the larger part of the United States where the Washingtonian system prevails. In the latter the land is laid out in townships, ranges, and sections, and there is no possibility of overlapping surveys; while in eastern Kentucky every man commenced his survey wherever he pleased and without any reference to former surveys or established base lines.

True, the law compels the entryman and the surveyor to make affidavit that the land "has not to my knowledge and belief been previously entered, surveyed or patented in whole or in part." But that one saving clause put in for the benefit of the honest man who might make an unintentional error also opened the door for one who was too shiftless to investigate and for the man who did not want to know.

As to the first group of Old Virginia Land Grants; these were large grants made by the state of Virginia previous to the granting of statehood to Kentucky, and made largely to speculators and real-estate boomers. One of the conditions of these grants was that the grantees take possession of and improve the land within 6 years of the time of making the survey. A very few of these, such as Rev. James Madison surveys of what is now Pike and Floyd counties, were perfected and from which a perfect chain of title and possession can be traced.

The one particular grant that has caused more trouble in the Sandy Valley than any other is the Wolcott survey. This has been traded upon in the North and East, and a set of unscrupulous attorneys and officeholders have recorded deeds to it or parts of it, so that on paper a chain of title to large blocks can be shown, but the surveyor who can locate these blocks or even the external boundary of the survey is a dandy. Several years ago, in Chief Justice Marshall's time, this survey was declared void by the Supreme Court of the United States.

The other grants lay dormant and no one claiming title under them settled on the land or attempted to pay taxes on them till about the year 1905-1906, when certain New York speculators, thinking to gobble up a large portion of the valuable coal lands of this section, attempted to list them for taxes. This brought on a suit that was carried through all the courts, and finally the Supreme Court of the United States declared them forfeited.

Group 2 takes in most of the surveys in this territory. The first active surveying by actual settlers in the Upper Sandy Valley was begun about the year 1800, and until after the War no advantage was taken of the no limit to the number of acres in a survey. On the other hand, as most of the first settlers were poor and only looking for farming land, their surveys were small and lay along the beds of the streams, they thinking that no one would want the hill back of them, they would thus save the investment and taxes and still have the hill land for grazing and timber.

At this time what has proved a bad practice was started. Instead of running all around the proposed survey as is contemplated by the law,

*Pikeville, Ky.

the surveyor would run along the bottom lands, marking corners and then platting up what lines he had run he would "call" such courses and distances "to a stake" for a corner, as would close the survey and embrace as he guessed what land the entryman wished to take in. This was not material except that it furnished no means of checking an error, so long as the surveys were confined to the lower land; but as the country became more settled and it became necessary to go to the smaller branches for land, the surveyor in estimating the distances would often overshoot his mark; so that in later years when these surveys were actually run out, the "stake calls" would be found to extend over the top of the ridges on to the waters of the adjoining creek. The settler on that creek doing the same thing from his side, the two surveys would overlap; and gradually as the desire for land grew and the surveys were made larger, these same stake calls extended farther, so that in many instances there are three or four overlapping surveys, and the writer knows of one instance of seven.

This having been an established custom, after the civil war, a class of surveys were made taking in from 100 to 100,000 acres and having "stake calls" of from 500 to 5,000 poles long, so that the exact locations of many of these are not definitely known, and in making them the owners, excluding "prior grants," intended to gobble up all the unappropriated land within the boundary that they supposed they were covering with their survey, but in many instances the "calls" missed much of the territory intended to be covered, as shown by the plat. As no exterior lines were marked, and as yet their location is indefinite, they form a vague basis of title and should be forfeited under the same law that applied to the Virginia land grants.

Group 3. About the year 1872, the Legislature enacted a law limiting the area of a survey to 200 acres, but certain counties were excepted, and in 1901, the general statutes covering the entire state curtailed the right of entry to 200 acres and from this time the surveys of Group 3 were made, and many of these were made inside the boundaries of the large blanket surveys just mentioned.

The reader will bear in mind that these extreme eastern mountain

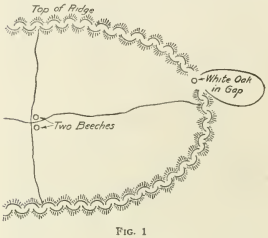


Fig. 1

counties had been cut off from the general progress of the country by their very mountain fastness, and were farther from the state capital as far as convenience of travel, than San Francisco is from New York. The result was that many honest farmers buying out another settler and finding that his patents did not cover the land traded for, would run out a new survey taking in what land he claimed, and paying no attention to the lines of former surveys, thinking that a patent from the state was as good a title as he wanted. In this way many junior surveys designate the lines of actual possession.

Now a word as to the surveyors and their work. The earlier surveyors were men who had come to this country from the older colonies and were educated men and their work is fairly well done. But as generation succeeded generation, as a natural consequence of the seclusion of the country the standard of education dropped and with it the standard not only of surveyors, but that of the other professions, dropped rather than progressed. And to add to the natural falling back of mankind, due to seclusion, came the evils of the civil war, so that many of the surveys made between 1850 and 1900 are very defective. Nor was this true of surveys only, but of deeds; the conveyancers being Justices of the Peace, or Notaries Public, whose knowledge of these things was very limited.

The surveyor who has old lines to retrace has many things to study besides simply the calls and distances of the survey or deed. When he finds his call or distances do not take him to the corner called for, he must resort to a study of how or what mistakes could have been made, and frequently the contours and physical features of the ground will be a good guide as to what was intended to be done, and bearing in mind the decisions of the courts, the location intended can generally be determined. As an illustration, the writer was called on to relocate an old survey of which the beginning corner and the fifth corner were standing on the bank of the river, and the fourth corner called for a tree standing on the bank of the river, but which had been destroyed. Now to commence at the beginning corner and run the courses and distances as called for in the description of the patent would land at the end of the third call or fourth corner up on the hill, 400 feet from the river, and the fifth corner or end of the fourth call would land in the middle of the stream 500 feet down river from the standing corner, and continuing the next course and distance would take me into the state of West Virginia.

A careful examination revealed the fact that if the variation of the needle for the year of the patent had been set off on the wrong side, then following the courses and allowing for an error in measurement of 20 poles in the third call, the lines would practically follow the river bank and come within 10 feet of the standing corner which is at the bend in the river, and the next course would follow the river bank. On this basis the writer located the remaining calls of the survey and the location

has been sustained by the courts. The writer could refer to many other errors, but this is a fair sample.

Some of the descriptions in patents and deeds are curiosities in literature, as, for instance, "N 29° E 50 poles to a white oak on a fence point and up the same"; N 40 to maple by a cliff should read N 40° W 100 poles to a maple by a cliff. This error was easily found as North 40 poles took us into a creek bottom, while at N 40° W we could see a cliff and at the foot of it we found the maple. A harder one was "S 60° to a hog wallow on the road." This call led from the top of a high knob around the foot of which the road lay. On second trial S 60° E nearly 300 poles took us to a wet place or small spring in the road near the cliff and from there the next call took us to the marked corner. The most baffling on first reading was this description in a deed: "Beginning at two beeches at the mouth of two drains, then up both sides of the mountain to a white oak in a gap." On reading this one might expect to be obliged to solve the problem of being at two places at one and the same time, but on the ground it was easy, as Fig. 1 will show. The two drains came into the main branch directly opposite one another. The vendor claimed all the land drained by the branch above this point. He merely mentioned the white oak as a passing corner.

The custom of the purchaser making the survey and abstract has been pretty well established in this section, and a prospective investor should see to it that an accurate map is made showing the location of all patents and deeds, as this is necessary before any lawyer can make an abstract worthy of the name.

This has been done by most, but not all, of the mineral land and mining companies, and those who did not do this at the time of purchasing are finding it necessary to do it now, for as the mineral lands get more valuable, the cost of settling overlaps and conflicts is higher.

This article is *not* written to scare any one, but to explain the situation. The writer has spent 12 years in this field, following his profession, and knows that titles are as safe here as in any country, if proper care is taken in protecting them, and where overlaps or conflicts occur, they are in 99 cases out of a 100, settled amicably and justly with very little trouble.

The Meridiograph

The Meridiograph is an instrument which is highly recommended by some engineers in the West who have made use of it in determining a meridian. As shown in Fig. 1, it consists of two concentric rotating disks and a reading arm. Finely graduated scales on these disks permit the data to be laid off to an accuracy of about 1′.

The scales, beginning with the outermost, are:

Number .10 to 1.00, complete circle, for numbers A, B, $(A + B)$.

Bearing 20° to 88° 44′, approximately 1⅔ loops, for true bearing of sun.

b 10° to 60°, approximately ¼ loop, for either altitude or latitude.

a 10° to 60°, approximately 1 loop, for either altitude or latitude.

a 10° to 60°, approximately 1 loop, for either altitude or latitude.

b 10° to 60°, approximately ¼ loop, for either altitude or latitude.

DECL 1° to 23° 30′, approximately 1⅓ loops for declination.

The names of all scales are on the arm, exactly over the graduations; this obviates searching for any desired scales. Nearly all graduations are 5- or 10-minute spaces; angles may, therefore, be read to an accuracy of 1 minute.

The transparent celluloid cover prevents the disks from moving accidentally after they have been set, and also protects the scales from wear and dirt. The inner disk is rotated through the finger slots above and below.

To find true north, measure the

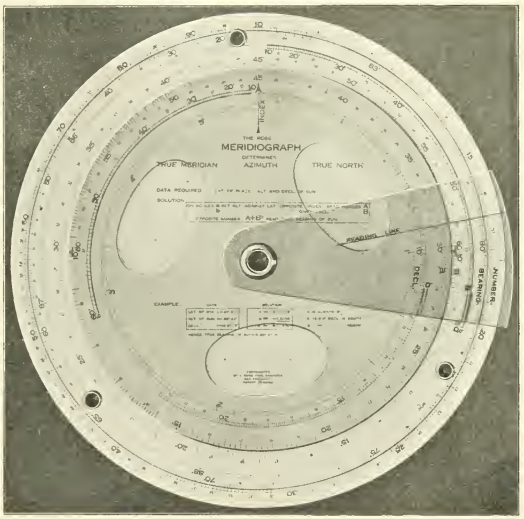


Fig. 1. The Meridiograph

sun's altitude, take its declination from the Ephemeris, and the latitude of the station from a map. Set these data on the Meridiograph, by means of the reading arm, thus:

On scales *a* set altitude against latitude, and opposite *Index* read number *A*. On scales *b* set altitude against latitude and opposite given declination read number *B*. Opposite $(A + B)$ read true bearing of sun.

On the two *a* scales the altitude is set against the latitude; it is immaterial which is set on which, as the scales are identical; but set arm on the outer disk first, then turn the inner disk till the proper reading is under reading line. The same applies to the two *b* scales. Note that the two *a* scales produce number *A*, while the *D E C L* with the two *b* scales produce number *B*.

ANALYSIS OF SCALES

1. Scales *b* are not graduated as minutely as the others because their effect on the answer is correspondingly less.

2. Read number scales as closely as possible to the fourth significant figure, estimating fractional divisions into tenths.

3. The values of *A*, *B*, and $(A + B)$ will, in practice, nearly always lie between, .10 and 1.00, as given by the decimal point in Number scale. The exceptions are unusual, and the rules for them are:

4. *Number A.*—South of United States, if both latitude and altitude are so low that $H° \times L°$ is less than about 300 (when Index falls to left of .10), then *A* is $\frac{1}{10}$ of number opposite Index. Thus, set on scales *a* 15° against 18°, then opposite index read $A = .0871$, and not .871.

5. North of United States, if both altitude and latitude are so high that $H° \times L°$ is more than about 2,000 (when Index falls to right of 1.00), then *A* is 10 times the number opposite Index. Thus, set on scales *a* 50° against 43°, then opposite Index read $A = 1.112$, and not .1112.

6. *Number B.*—Near the equinoxes, when the declination is less than about 4° (exactly, less than declination opposite number .10 after the *b* scales have been set), then *B* is $\frac{1}{10}$ of number opposite the given declination. If the declination is less than 1°, *B* is less in proportion.

Thus, set on scales *b* 30° against 40°, then if declination is 1°, *B* is $\frac{1}{10}$ of .2615. Thus, set on scales *b* 30° against 40°, then if declination is 20′, *B* is $\frac{1}{3}$ of .02615.

7. $(A + B)$ *vs. Bearing.* When the sun is nearly due east or west: If $(A + B)$ is less than .10 set arm on 10 $(A + B)$, and read inner loop of Bearing. If $(A + B)$ is less than .02325 (this corresponds to bearing 88° 40′, largest on scale, and occurs rarely), then set arm at 100 $(A + B)$ read inner loop of Bearing, then $\frac{1}{10}$ of this reading + 81° = true bearing.

Thus, if $(A + B)$ is .3400, set arm on .34 and read on outer loop 70° 07′; Thus, if $(A + B)$ is .0340, set arm on .34 and read on inner loop 88° 03′; Thus, if $(A + B)$ is .0034, set arm on .34 and take $\frac{1}{10}$ of 88° 03′ + 81° = 89° 48′.

The Training of Rescue Brigades

Methods Employed By the North Staffordshire (England) Coalowners' Central Rescue Station

Abstracted for The Colliery Engineer

At a recent meeting of the North Staffordshire (England) Institure of Mining and Mechanical Engineers, Mr. G. H. Greatbatch read a valuable and instructive paper, describing the methods employed in Training Rescue Brigades at the North Staffordshire Station, at the Berry Hill colliery, Stoke on Trent, and stated that up to December 31, 1913, 418 men were fully trained and passed for certificates.

The training station consists of a large room in which is stored the breathing apparatus, etc., and adjoining smoke gallery in which the men are trained, and, a few yards distant, another room fitted with washing accommodations, in which the men change their clothes. While the gallery used was not an ideal one for the purpose, and will be replaced by a permanent up-to-date building, Mr. Greatbatch stated that the men were trained in a very efficient manner, and have accomplished rescue and recovery work in the North Staffordshire coal field, which up to the present constitutes a record for the whole of Great Britain.

Both breathing apparatus and reviving apparatus are used, and the equipment of the station is well in excess of the requirements of the British Rescue and Aid Order.

A supply of materials, all necessary spare parts for the various apparatuses, and birds, are kept in stock. In the colliery yard a motor van is housed, ready for immediate dispatch to any disaster. It is equipped with 12 complete sets of breathing apparatuses fully charged, an ample supply of charging materials, electric lamps, reviving apparatus, ambulance supplies and a quantity of spare parts. The motor van is taken out each week for a short run to keep it in order, and the whole of the 12 sets of breathing apparatus are changed weekly. Telephonic communication is established between the instructor's house and the rescue station at the colliery, and arrangements have been made with the district superintendent to have priority of calls. The staff consists of an instructor and assistant instructor.

The brigades are selected from volunteers by the managers of the individual collieries, and before being sent for training are subjected to a very strict and searching medical examination. Unless they are absolutely physically fit they are not accepted. This has been found to be a very necessary precaution, and in addition each man is informed that if he is suffering from cold, or

any other slight derangement, it is much better to miss a practice, as the work is too serious to run any risks. It is absolutely certain that men working strenuously each day, and consequently in good hard working condition, are able to wear the apparatus with less fatigue, and consequently less fear of a breakdown, than a man who is in a soft condition. Each brigade consists of six men, No. 1 man acting as leader and No. 6 man as captain.

The training consists of 12 practices at the station, each of 2 hours' duration—one practice a week for 12 consecutive weeks.

First Practice.—This is wholly occupied by the instructor's thorough explanation of the apparatus, and by marching round the station wearing the mouthpiece only, which is called "mouth drill."

Second Practice.—The complete apparatus is worn and the men merely walk about the station.

Third Practice.—The men wearing the apparatus are put into the gallery and do a limited amount of work.

Fourth Practice.—The men work in the gallery for the first 45 minutes, and then sulphur fumes, not strong, are turned in for the remainder of the practice.

Fifth Practice.—The whole of the work is done in the gallery filled with strong sulphur fumes; the program of work at this and the remainder of the practices is as follows:

A weight of 56 pounds is pulled to a height of 8 feet, ten times by each member of the team. Bricks are loaded in a wagon, pushed along a tramway, and a stopping is built on an upper platform, then taken down, and the bricks taken back to their original position. Three settings of timber are fixed and covered with brattice cloth, and a dummy is placed on a stretcher and carried through them. The men are taught to creep through small apertures, while equipped with the breathing apparatus. Wooden blocks are carried, and a stopping built in a confined space—in fact, the practice is as near alike to actual pit work as it is possible to make it. Previous to each day's training, the instructor explains to the men how to proceed in the different circumstances they may be placed in during actual work down a mine.

The men are taught to put on the apparatus expeditiously and to thoroughly but quickly test its condition.

At the termination of the training, colliery managers are appointed to examine thoroughly the men in their work and the description and use of various parts of the apparatus, and also as to how they would proceed in actual rescue work down a mine after a disaster. They are also examined with regard to the building off of workings affected by gob stink, and no man is certified until efficient.

During the training of the 418 men who obtained certificates and the few that fell out, the following incidents occurred:

August 4, 1911. The leader of a brigade turned off his oxygen supply whilst walking around the apparatus room and collapsed. On reviving he remarked: "If dying is as easy as that, then I'm not afraid to die."

September 8, 1911. No. 5 man of a brigade collapsed in the gallery from the same cause. When brought round, he charged one of his mates with pushing him down. It appears when he was falling he tumbled against him.

November 3, 1911. The captain of a team, when breathing oxygen for the first time, and naturally taking it easy, was troubled with too great a flow. He turned off his main valve, instead of pressing the relief valve, and in a few minutes became unconscious. Coming round, his first words were: "What am I doing here?"

February 16, 1912. A member of a brigade turned off the main valve in the gallery, and when collapsing grazed his arm. He was brought round in the fumes by the other members of the team.

August 12, 1912. Two men, belonging to the same team, turned off their main valves and collapsed in the apparatus room, but quickly came round. Before falling, the face of one became a curious green color.

February 25, 1913. When building the block stopping under the staging, one of the team collapsed through shortage of oxygen, owing to the main valve being accidentally closed. The captain, a man holding a first-class certificate, at once tried the main valve and found it shut. He opened it, adjusted the apparatus, and in a short time brought the unconscious man around without bringing him out of the fumes. Great credit was due to the captain for the able and cool manner in which he dealt with this emergency. The instructor was watching the occurrence through the window.

May 6, 1913. When working in the gallery, a captain turned his valve spindle completely out, losing all his oxygen in a few seconds.

Several cases have occurred in the gallery where the main valve has been accidentally closed, but these have been noticed immediately and no ill effects caused.

December 2, 1911. No. 4 man in a brigade had to come out of the gallery after 1 hour 45 minutes work, on account of the use of inferior supplies for the apparatus.

January 8, 1912. No. 5 man in a brigade had to come out after 1 hour and 50 minutes work, for the same cause.

February 13, 1912. No. 5 man in a team had to retire a few minutes before time, for the same cause. The source of supply of material was changed and this trouble was obviated.

August 20, 1912. A leader of a team came out of a gallery complaining that he was breathing the sulphur fumes. It was found that in putting on the mouthpiece he had allowed a portion of his moustache to get between the rubber and his lips, and the fumes were being inhaled through the opening so caused.

July 19, 1912. A rescue man's saliva trap became disconnected

after 1 hour 25 minutes work in the gallery. He came out and had it replaced. Had it occurred in the pit, it could have been replaced quite as easily without any ill effect.

An instance occurred in the gallery of a man throwing a piece of timber with a jagged edge, which accidentally struck a portion of the breathing apparatus and put it out of commission. No ill effects occurred, but if such an accident happened whilst doing actual rescue work in an irrespirable atmosphere, serious results would probably have occurred.

On January 15, 1912, a brigade, while being examined, went through their work very slowly, and No. 2 man, being anxious to get the work done, overexerted himself, and had to be assisted out of the gallery. His lips turned purple. This was after 2 hours work. The others continued working. Presently the leader informed the captain that he was short of oxygen. The latter examined the man's apparatus, and by mistake turned the wrong valve, which would have resulted seriously had it occurred in a mine in an irrespirable atmosphere.

These instances are of importance in showing the necessity of great care in the use of the breathing apparatus, and accurate knowledge of its operation. Cases of overexertion prove that the work is limited in its extent. Accidental or mistaken manipulation of valves shows the necessity of the captain of a team being specially proficient and cool headed so that he will remedy the error quickly.

Mr. Greatbatch stated that experience had demonstrated that it is impossible to fix an exact amount of oxygen to meet the requirements of all men. If it is fixed to suit a man who requires more oxygen, it will be too much for the man requiring less, and in the latter case the wearing of the apparatus will become irksome. For this reason each man should be taught to control the supply of oxygen to meet his own requirements.

One great object is that the apparatus shall be comfortable; if not, and the man feels any discomfort, he will have his mind concentrated on it. Most likely he will become irritable, and the moment he gets to this condition he is within measurable distance of trouble. When this happens, he should most certainly return to the surface, and should not be asked to go down the pit again.

It is advisable that a man should be perfectly fresh and in good physical condition before wearing the apparatus in actual rescue work; also, he should not go down a mine to work with a full stomach.

In training the men, one precaution that has been drilled into them more than any other is that on no occasion must they overexert themselves. They have been told that, if they do, there is every probability that they will collapse, and, if in an irrespirable atmosphere, the result would be death to the man, and most probably to others of the team.

Mr. Greatbatch instanced a case where the men in a team engaged at actual rescue work in the mine complained of an excessive amount of oxygen, and claimed that they did not need any more than they used in practice work in the gallery. He told them this was against theory, and contrary to the opinions of authorities on the subject, but they replied, "we are using it, and we know what we feel."

As his own opinion he said:

"I am afraid that to increase the supply of oxygen for the purpose of increasing the amount of work to be done by each team is a grave mistake, and will most probably end in disaster to the team.

"In actual work down a mine we have proved conclusively that whilst the work accomplished by each brigade is very limited, very efficient work can be done, providing every care is taken to follow out the instructions given to the men at the station. The absolute necessity of looking to the most minute details should always be kept in mind, and nothing left to chance."

Unfortunately, the popular idea of rescue apparatus, and the work that can be accomplished by its use, is not borne out in practice; for, in addition to the limitations before mentioned, you have the fact that a man working in a dense smoke cannot see, and loses all sense of position.

In response to inquiries brought out in a discussion, in which the work of the training station was strongly commended, Mr. Greatbatch stated that it was the practice at the gallery to give 1½ liters of oxygen, and in actual mine work from 1¾ to 2 liters. It was found necessary to give more in actual work. Personally, he did not think, however much they increased the oxygen supply, they would get more strenuous work; by requiring more strenuous work they would be bound to bring a man down. Moreover, he felt quite sure they could not fix the amount of oxygen to suit all men; what was sufficient for one man was too little for another. Regarding a suggestion as to working on the fire brigade system of keeping a certain number of men ready at the rescue station, he said that he could not see how they could make it a success by having a limited number of men trained and kept like a fire brigade. In the case of one station, he had been told that 24 men had been trained for this purpose. He, however, did not see how 24 men could be sufficient in case of a disaster, because they could not expect men to do more than 2 hours work. As regards testing men, he said he held very strong opinions about that, and thought the men should be examined periodically. He also held the opinion that they had too many men trained. Having to depend upon volunteers, they did not have the selection of the men; and if he had the opportunity of picking them out, he should discard a certain number. They did their work all right, but they were wanting in some respects. He could make more efficient brigades by a process of selection, and they would certainly

never need the number of men they had. They would have to do something to see that the men remained physically fit; there should be a medical examination every 12 months. If they had fewer men, they would have more efficient brigades, because the selection would be stricter.

Electro-Pneumatic Air Compression

Written for The Colliery Engineer

Until recently electricity and compressed air were natural opponents, so far as their application to mining was concerned. Each had supporters, and cogent arguments have been offered as to the relative advantages of the two systems. Undoubtedly electricity has an important advantage in the ease with which it can be transmitted and in the comparative absence of loss in transmission. However, pneumatic drills and other air machinery have reached a high state of efficiency and mechanical perfection.

This controversy was inevitable so long as the practice of locating the compressor in a fixed position near the shaft was in vogue; and until recently certain practical difficulties in the construction of small compressors had a deterring influence on the construction of portable air-compressors for mine purposes. Recently, two most interesting forms of electrically driven portable air compressors have been designed in Great Britain. The compressor shown in Fig. 1 was built for a Welsh colliery belonging to Messrs. Guest, Keen & Nettlefold. It has been placed in the mine to supply air to reciprocating coal cutters and is driven by an electric current generated at the surface.

The compressor is single stage and direct coupled to a continuous-current motor. Its four cylinders are arranged radially in a circular-shaped casing, each one being fitted with a piston and four connecting-rods, all being driven by a common crankpin. The casing contains an annular space through which the cylinders pass and which is used as a water-jacket. Each cylinder forms a separate single-acting compressor and as they all deliver into a common passage, a practically continuous supply of compressed air is secured, and, owing to the pressure being always in one direction, the compressor can be run at relatively high speeds. The compressor has no intake valves, air being admitted above each piston by means of a port which coincides with a similar port in the top of each connecting-rod

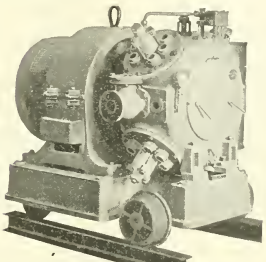


Fig. 1. Electro-Pneumatic Air Compressor

during the intake stroke. Near the end of this stroke the piston overruns the ports cut through the cylinder while making direct connection between the cylinder and the inside of the compressor casing which is arranged to form a vacuum chamber. As compared with compressors with spring-loaded valves, there is said to be a gain of at least 5 per cent. in the volume of its efficiency, as the cylinders are filled with air at atmospheric pressure at each stroke instead of at a reduced pressure due to the resistance of the valve springs. The delivery valves are fitted at the outer end of each cylinder and are open during the compressing stroke as soon as the air has reached the required delivery pressure. Through them the compressed air goes to a delivery passage in the casing and thence through any of four openings provided to the receiver. The delivery valves are light, made from steel, and by using a number to each cylinder, their weight and lift are reduced, besides working in silence and with small wear. The torque on the shaft is practically constant due to the subdivision of effort by dividing up the cylinder capacity, and this enables the motor to work efficiently and without sparking. The field magnet castings are bolted to the bedplate which carries the compressor. Precisely the same construction is adopted for alternating current motors, a suitable number of poles being adopted to give the most suitable speed.

An interesting test was taken on one of these machines and the data obtained are recorded in the following table:

Table 1. Test of Air Compressor

Rated size of machine, cubic feet of free air per minute	230
Diameters of cylinders, inches	10
Length of stroke (effective), inches	42
Average revolutions per minute	325
Average delivery pressure, pounds per square inch	70
Average volts	460
Average amperes	68
Average electrical horsepower	42
Motor efficiency, per cent.	88
Brake horsepower	36.9
Capacity of air receiver, cubic feet	93
Revolutions taken to fill receiver (full pressure being maintained all the time in auxiliary receiver)	595
Mean temperature of air in the receiver, degrees F	100
Mean temperature of air outside the receiver, degrees F	65
Mean temperature of air at delivery of compressor, degrees F	160
Equivalent volume of free air delivered into receiver per minute, cubic feet	237
Equivalent volume of free air reduced to 65° F., cubic feet	222
Volume swept by pistons of compressor, cubic feet	255
Actual mean effective pressure from diagram at 65° F. inlet and 160° F. outlet temperature, pounds	30
Theoretical power required from this diagram, horsepower	29.1
Apparent volumetric efficiency based on time taken to fill reservoir against full pressure $\frac{237\times100}{36.9}$, per cent.	93
Real volumetric efficiency corrected to atmospheric temperature $\frac{222\times100}{255}$, per cent.	87
Overall efficiency $\frac{29.1\times100}{36.9}$, per cent.	79
Mechanical efficiency—by deduction, per cent.	91
Isothermal mean effective pressure, pounds	25.74
Theoretical power assuming isothermal compression, horsepower	24
Thermal efficiency $\frac{24\times100}{29.1}$, per cent.	82½
Absolute efficiency from actual power on shaft to isothermal diagram, per cent.	65.2

From the above it will be seen that the efficiency on the basis of isothermal compression is over 65 per cent., while the efficiency calculated by Professor Rateau's method, by which in the absence of water cooling the efficiency is deduced from the temperature rise of the air in passing through the machine, is 79 per cent. This latter efficiency

takes into account leakage and clearance losses and is undoubtedly good for a machine dealing with only 230 cubic feet of air per minute. When the great efficiency of electrical transmission is borne in mind, together with the fact that the machine can be placed close to the spot where the compressed air is required, it will be seen that a most important advance has been made in the application of compressed air to mining work.

A Lecture on Technical Reports

"The first thing an engineer must remember when he is retained is that he stands in a fiduciary relationship to his client. He is retained to furnish a report which is to give facts and data which will form the basis for decision as to the advisability of making an investment. The accuracy of these facts must, therefore, be unquestioned, and they must include all the available material. Moreover, since the report is usually addressed to non-technical people, the language must be clear and simple. The reader should be assumed to know nothing of the subject, and technical terms should be defined when used for the first time."

The above remarks were made by Mr. Arthur D. Little, in a recent lecture before the Chemical Society of the Massachusetts Institute of Technology. A large audience greeted the speaker because of the long and varied experience which he has had in consulting practice as a chemist and engineer. Continuing, Mr. Little emphasized the fact that an engineer's success depends on his ability to influence other men, and that therefore the cultivation of good English was an absolute necessity.

"The form of the report is extremely important. Although paper, type, and binding have nothing to do with the subject matter, they influence the reader's opinion, and should be carefully considered. The title page should be attractive, and the table of contents should be very full. The report proper opens with a statement of the object and scope of the report, the general method of attack, and of obligations incurred in the preparation as to sources of material, etc. The body of the report is usually divided into sections, which are treated as separate units, with a summary after each, and a complete summary after the last one. Diagrams are advisable wherever possible, and at the conclusion, an appendix is placed, which contains all original material, results of analyses, photographs, personal letters, copies of newspaper clippings, etc., and a bibliography of the literature of the subject."

Manufacture of Briquets in Holland

*By Frank W. Mahin**

Large quantities of briquets, made chiefly of peat and charcoal, are used in Holland, the reason being that no coal is mined in Holland except in a remote southeastern corner, where mines are worked which extend under the border line into Germany. A common fuel is therefore briquets of peat reinforced for cooking and heating purposes by charcoal or Welsh anthracite coal.

We are told that the first briquets were made of lignite—brown or wood coal, intermediate between peat and coal proper in certain respects. It is explained that the use of lignite as fuel was attended by various drawbacks, and that to overcome these the briquet was devised and lignite was enhanced in value as an article of commerce. The first briquets were made literally by hand and foot. The material was sifted, then well dampened, and then thoroughly kneaded—this being done by men who stamped the mixture with their bare feet. The plastic mass thus formed was put in molds and dried in the open air. A clever workman could make 1,200 briquets in 10 hours. But they had serious defects, the gravest being a lack of cohesive properties which made them totally unfit for transportation. However, about 50 years ago, a machine was invented which substantially overcame the defects, and from which have evolved the machines of today.

By the present method of making lignite briquets, the moist coal as it is raised from the mine is crushed fine between heavy rollers and then dried in ovens till only 5 to 15 per cent. of moisture remains. It is not completely dried, as that would reduce its plasticity. Then a stamping press shapes the mass into briquets, under a pressure of over 1,000 atmospheres, and the drying occurs in specially built ovens. In certain cases, as coal dross, for instance, the material requires the addition of a cohesive substance, coal tar or a species of rosin being used, which is added in a pulverized or melted state. This mixture is made into briquets under a pressure of 100 to 200 atmospheres.

The foregoing description applies, in a general way, to the manufacture of briquets from charcoal and peat in this district. The briquets called charcoal are composed chiefly of that material, with the addition of other combustible substances, such as tar, saltpeter, and charred peat. The relative proportions of these ingredients is a trade secret

Briquets are specially made in this district for various definite uses. Certain peat-charcoal briquets are used in the casting of steel, for which the low percentage of sulphur they contain makes them peculiarly suitable. Another briquet is for use in a flatiron. It is heated on a spirit lamp or in a fire, and when put in the flatiron will, it is said, give out a steady heat for 8 to 10 hours, and thus prove a great aid to laundry work. Besides these special kinds, varieties of briquets are made for burning in stoves, where they are employed either as the sole fuel for lighting anthracite coal, which is much used,

A considerable export trade in Dutch briquets has been acquired, especially with England, and it is believed that the recent introduction of the improved manufacturing facilities will increase that trade.

*U.S. Consul, Amsterdam, Holland.

Rectangular Coke-Oven Plant

Of the Sykesville Coke Co., at Sykesville, Jefferson County, Pa.—Description of the Methods of Operation

By W. N. Judd

DURING the past year the Sykesville Coal Co. has completed and put in operation its plant of 200 rectangular ovens and the auxiliary electric and coal preparation plants.

The plant immediately adjoins that of the Cascade Coal and Coke Co. The two plants are operated under one management, the entire output from both plants being taken by the blast furnaces of Rogers, Brown & Co., at Buffalo, N. Y.

All coal is hoisted from a single shaft and dumped into a hopper bin from which it is delivered as required to the coal preparation plants of either company by feeder conveyers.

The coal preparation plants are essentially duplicates, each consisting of a Bradford breaker for removing the bone, a Williams mill for crushing the coal, and an inclined belt conveyer delivering the crushed coal to a 1,000-ton storage bin.

The refuse from the breakers is used for boiler fuel, and is delivered by conveyers as required either to the Cascade or the Sykesville boiler house. The coal preparation and conveying plant was installed by the Link-Belt company.

The two plants are operated on an interchange of power. The power plant of the Cascade Coal and Coke Co. consists of 1,200 horsepower of Aultman-Taylor (B. & W.) water-tube boilers, a 20″ × 36″ double conical-drum Vulcan hoisting engine, two direct-connected, 200-kilowatt, 250-volt, direct-current, engine-driven Ridgway generators, three 26″ × 17½″ × 24″ × 30″ Norwalk air compressors, a 20′ × 7′ Robinson fan, direct connected to a 24″ × 24″ engine, a 16″ × 30″ × 20″ × 36″ compound condensing Jeanesville mine pump and several smaller auxiliary pumps.

In the Sykesville Coke Co. power house are installed 600 horsepower of Aultman-Taylor boilers, two 375 KVA. 2,300-volt, A. C., low-pressure, Ridgway turbogenerators with Wheeler surface condenser and a Boyts, Porter & Co. 20″ × 10″ × 24″ pump.

The steam header from the Sykesville boilers is connected to the Cascade steam header so that the two boiler plants act as a single system. The exhaust steam from the Cascade engines is carried by a pipe laid in a concrete duct to the low-pressure

Fig. 1. Coal Preparation and Power Plant

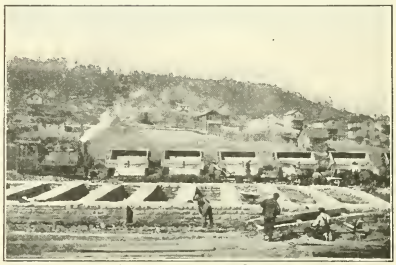


Fig. 2. Foundation Walls of Coke Ovens

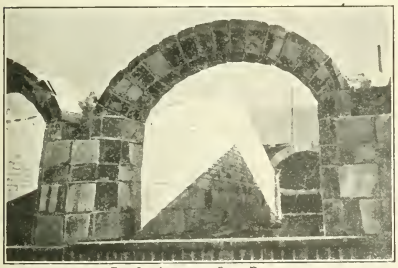


Fig. 3. Arches to Oven Doors

Fig. 4. Ovens in Course of Construction

Fig. 5. Ovens in Course of Construction

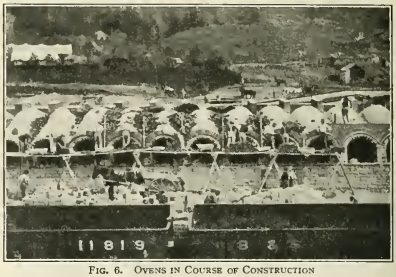


Fig. 6. Ovens in Course of Construction

turbines in the Sykesville power house.

The A. C. current is carried to a substation in which is installed a motor-generator set for furnishing 250-volt D. C. current for the electric-haulage system in the mine. A second motor-generator set is installed in the Cascade power house, which supplements the power generated by the engine-driven generators. The D. C. current for motors operating the Sykesville coal preparation equipment and larries is taken from the Cascade switchboard.

Mine water is used for the condenser and for quenching the coke in the ovens. The 18-inch discharge main from the mine is by-passed to a well in the power house. The condenser circulating pump takes its suction from this well and the discharge from the condenser is caught in a second well. The water for coke ovens is pumped from this second well to a concrete reservoir located on a hill, giving a head of 150 feet above the oven seat at the upper end of ovens. All water in excess of requirements flows over a weir from the second well to the sewer.

The ovens are 5 feet wide, 31 feet long, 4 feet 7½ inches high at the doors and 8 feet 6 inches high at the charging trunnel, and are spaced 7 feet 3 inches center to center.

On the only location available for the ovens, parallel to the beehive oven plant of the Cascade Coal and Coke Co., the natural surface of the ground was from 8 to 15 feet below oven seat. The foundations of the ovens to within 6 feet of oven seat were built of dry rubble masonry, but an innovation in the filling of the "pockets" or spaces between cross-walls of ovens, was adopted in the use of granulated blast-furnace slag instead of the usual clay filling. The ease with which this material could be placed and compacted proves it to be a very satisfactory material for such deep fills and there was practically no settlement of oven bottoms when the ovens were fired. In other respects there was no material change from the usual practice in the construction of rectangular ovens.

Fig. 1 shows the power and coal preparation plant of the Sykesville Coke Co., during construction, also the head-frame, tipple, and other buildings of the Cascade Coal and Coke Co. in the background.

Fig. 2 shows the foundation walls to oven seat. On the right the space between walls is being filled and tamped with clay and loam.

Fig. 3 shows the arch to the door, and inside the large lining brick, and the construction and shape of the side walls.

Fig. 4 shows the walls between the adjacent ovens and the arch centers in place previous to laying the crown brick.

Fig. 5 shows the ovens on the right crowned, with end walls between the two piers. This is an excellent illustration of the use of

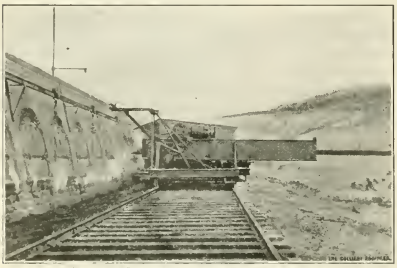


Fig. 7. Watering Machine, Ram, and Motor

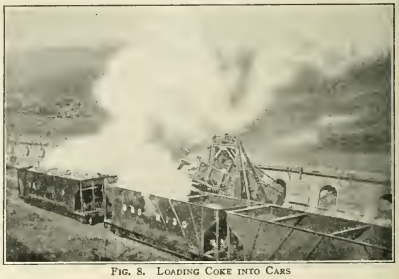


Fig. 8. Loading Coke into Cars

headers in connecting end walls with side walls.

Fig. 6 shows the oven crown with its barrel shape, and the red brick front wall and arch. In the background are shown the larry-track piers of red brick previous to their being covered with stone cap pieces.

Fig. 7 shows the watering machine and the ram motor.

The daily sequence of operations is as follows: Beginning at the upper end of the oven block, the doors at both ends of every alternate oven are opened just before the coke is quenched within the oven by the coke quenching machines. After watering, the coke is allowed to stand in the oven a short time until the heat of the oven has driven off the excess moisture. Then the pushing machine operating at one end of the oven pushes the coke on to the conveyer of the loading machine, at the other end of the oven which, running simultaneously with the pusher, delivers the coke directly into the railroad car, as shown in Fig. 8. The lower section of the door is then placed and a full charge of coal is dropped into the oven from the larry running on a track on top of the ovens. The leveling machine shown in Fig. 7, operating on the same track with the pusher, then brings the coal to a uniform depth for the entire length of the oven. The upper section of the door is then placed and all spaces between the two sections of the door and between the door and the oven are sealed with a mortar composed of loam and coke ash.

There are two coke quenching machines, one traveling on the pusher track and the other on the loader track, each quenching the coke in approximately one-half the length of the oven.

The Wellman-Seaver-Morgan Co. furnished the machines, which are supplied with water by hose connections from the valves located in recesses in the face walls of ovens. The ram, with a perforated-pipe spraying head which travels within the ovens, telescopes over the stationary pipe on the machine to which the water is fed at the rear.

The ram moves back and forth automatically between limits set to the travel desired. An automatic trip opens and closes the water valve on the machine just as the spraying head enters and leaves the oven. One motion of the operator's lever enters the ram into the oven and the reverse motion withdraws it when the coke is quenched. There is one motor on the machine for operating the ram and traversing the machine on the track.

The "pusher" ram is in one piece with rack on the bottom. The pushing speed of the ram is 15 feet per minute and the return speed 60 feet. There is one motor which, by means of friction clutches, operates the ram in either direction and traverses the machine on the track.

The coke-loading machine shown in Fig. 7, is built on the Mitchell patent, with special features relating to the design of the conveyer and its division into two sections.

The conveyers are of the apron type, attached to the overlapping plates of the conveyer are curved steel plates which contain the ash and braize as the coke is discharged over the head of the conveyer. The ash and braize caught by chutes are delivered on to the yard. The coke in passing from the first to the second section of the loader, is turned over so that any ash carried on top of the coke in the first section is shaken off and caught by the hook plates of the second conveyer.

The first section of the conveyer is fixed, but the second section is hinged so that it can be raised to clear the locomotive or lowered to the top of a railroad car. An adjustable apron is provided for filling in the space between the oven door and the machine. The machine is equipped with three motors, one for the traverse of the machine on the track, one for driving the conveyers and one for raising and lowering the second section.

The charging larries, built by the Phillips Mine and Mill Supply Co., have a capacity of 11 tons. One larry is equipped with two 30-horsepower motors. For a charging trip three larries are coupled 14-foot 6-inch centers so that three alternate ovens may be charged at one time.

The "leveler" shown in Fig. 7, consists of a 25-horsepower motor mounted on the ram box to drive the leveling ram through a rack and pinion: A 15-horsepower motor mounted on the truck raises and lowers the ram box as required for leveling the coal in the oven, and also by means of friction clutches traverses the machine on the track. The pusher and leveler were furnished by the Connellsville Mfg. and Mine Supply Co. At this plant there is a mud truck where the loam and coke ash screenings are stored and mixed under cover. There is an extension platform at the proper height for the men to daub the doors as soon as a charge of coal is leveled. At the end of a day's run the mud trucks are pushed to the upper end by the leveler on one side and by the loader on the other.

The W. G. Wilkins Co., Pittsburg, Pa., were the engineers for the Sykesville Coke Co., in the design and construction of this plant. C. C. Gadd is the general superintendent of both the Sykesville and Cascade plants.

Technical League of America

At the annual meeting of the American Institute of Electrical Engineers, a paper was read and discussion took place on the subject of combining the membership of the great national engineering societies in one association.

The primary object was described as "To foster and develop the human factor in the engineering profession, to place the engineer on the same plane as the lawyer and doctor," "for the discussion on engineering in general . . . except scientific and technical subjects . . ."

There was no adverse discussion and both paper and discussion show

beyond doubt that even the leading members of the great national societies, whose objects are to advance science and engineering, realize that something more is needed. What they realize may be stated in this way:

1. An organization separate from those of a scientific character is essential to develop the standing of the engineer as a social unit.

2. There is no "adjectical" distinction between engineers when their interests in society are to be protected or advanced. At such a time architectural, civil, electrical, mechanical, and mining men stand as a unit.

The offices of the Technical League of America are 74 Cortland Street, New York, and 3817 Olive Street, St. Louis, Mo.

Texas employs about as many coal miners as there are Hungarians in the West Virginia mines, namely, 5,500.

A New Rock Plane

In the Bear Valley shaft No. 2, of the Summit Branch Mining Co., near Williamstown, Pa., the problem of handling adequately the increased number of mine cars for the North Tunnel workings arose.

Under the old system the empty cars ran by gravity from the top of the car hoist to the White Seam gangway, 200 feet south of the shaft, from which place they were distributed where needed. Cars going to the North Tunnel workings were forced to wait until the loaded cars between the gangway and the shaft had been taken out. This difficulty was overcome by the use of the rock plane as shown in Fig. 1. Then in order to prevent the cars from running away on the 9-per-cent. grade, a pair of stringers was laid between the rails. The car axle running on these will lift the wheels clear of the rails, letting the cars down under perfect control, owing to the decreased speed.

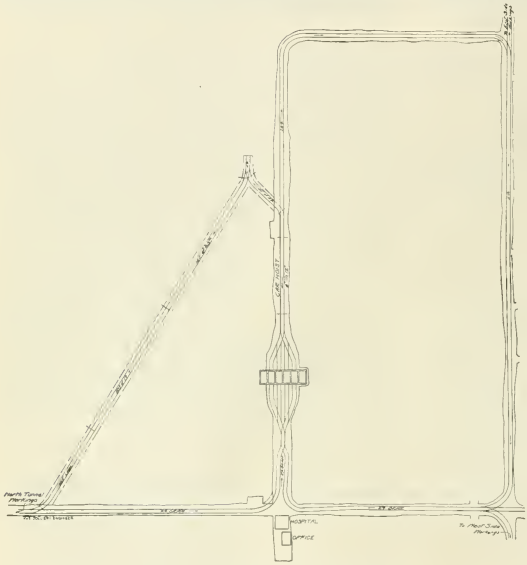


Fig. 1. Plan Showing Haulage Arrangements

Belgian Haulage Tests

The Annales des Mines of Belgium states that, at the St. Marie pit of the La Louviere and Sars-Longchamps colliery, tests were made on a haulage road 2,078 yards long to determine the relative cost of horse haulage and haulage with Ruhrthaler and Deutz bensine locomotives. The results of the test showed that the running cost per ton mile with the locomotive was only about 40 per cent. of the horse-haulage cost.

At the St. Quentin pit of the Centre de Jumet colliery on a haulage road 1,904 yards long, 12-horsepower locomotives of the Deutz type showed exactly the same cost per ton mile as horse haulage. At the Xhorre pit of the Kessales colliery, three months' experience with a benzine locomotive showed a running cost, including upkeep and depreciation of the locomotive, of 4.85 cents per ton mile.

In the first test mentioned, that of the St. Marie pit, only the running cost, including wages, was considered, and the cost per ton mile was only about one-fourth of the whole cost at the Xhorre pit. This great difference in the figures per ton mile cannot have been entirely due to upkeep repairs and depreciation at the Xhorre pit. There must have been local conditions that added to the haulage cost.

Efficiency Expert

[The following humorous poem was clipped from the *Chicago News* some time ago, and was handed to one of our editors by a prominent successful anthracite mine official.]

The devil opened the furnace door
And heaved in a shovel of coal
When out there popped on the scorching floor
A truculent, half-naked soul.
"Look here, good devil," it said, "I pray
You will pardon my seeming haste,
I am—you must listen to what I say—
Appalled at your awful waste!

"Two-thirds of your heat goes up the flue,
Your coal is but half consumed;
If a modern plant should compete with you
This business were surely doomed.
Your times and motions I've studied well
As you hustle the sinners in,
And I find you have here but a third-rate hell,
For the way it is run is a sin!"

The devil grabbed up that critic then
With an angry shake and a flirt,
And said: "Go back to the world of men,
You efficiency expert!
If you stay down here you will get my job!"
(Here he uttered a dismal groan),
"But if you go" (here he gave a sob),
"You will fix up a hell of your own!"

Practical Lubricating Tests

If Properly Filtered, Oil Can Apparently be Used Indefinitely Without Losing Its Lubricating Properties

Written for The Colliery Engineer

ONE frequently hears engineers speak of oil "wearing out," some maintaining that after oil has been in use for a certain length of time, it should be replaced by new oil.

In order to determine exactly what deterioration oil suffered when in constant use, an elaborate series of tests were recently made on different samples of a good mineral oil in the laboratories of Cornell University.

These tests proved that if oil is properly filtered, it can be used over and over indefinitely without losing any of its lubricating qualities. To show the value of the information obtained in these investigations, the data secured from the tests at a power plant in New York City have been selected as representing the most severe operating conditions.

The power plant referred to is equipped with a filtering system that supplies a total of 134 points of lubrication. This plant operates 20 hours per day the entire year. On account of the great variety of machines lubricated, the high load factor, and the exceptional temperature conditions, the work imposed on this lubricating system is probably as severe as can be found in any power plant.

To find out exactly how much oil circulated through the system, ten tests were made that gave the average amount as 150 gallons per hour, or 3,600 gallons per day, or an equivalent of 1,800 barrels per month. It is interesting to note that although this enormous amount of oil is supplied continuously to the bearings, it is only necessary to add to the system three barrels of oil per month, but that cannot be charged to natural shrinkage in the system, for large quantities of oil are drawn from the filters and used in cans for hand oiling of small pumps, valve gears and other bearings not connected to the system. But, charging three barrels against the system it is evident that the plant pays for less than two-tenths of 1 per cent. of the oil used for lubrication.

A series of friction tests were made on a Thurston Railroad Lubricant Tester having a hardened steel journal and bronze bearings with a total area of 20 square inches. In all tests the machine was run at a constant speed of about 360 revolutions per minute and the load applied in increments of 1,500 pounds, total pressure of 75 pounds per square inch. The test at each load was continued until the friction and temperature of the bearings had become constant.

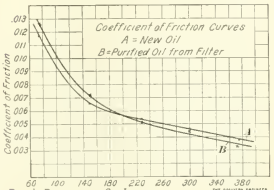


FIG. 1

The coefficient of friction taken was the lowest value found for each load; that is, as soon as a given load is applied, the coefficient is high at first, gradually falling off until it becomes practically constant. This latter figure is the one that represents the value obtained in ordinary practice where engines operate continuously for more than an hour. The temperatures taken were the highest reached; as each new load is applied, the bearing gradually heats until the temperature becomes practically constant.

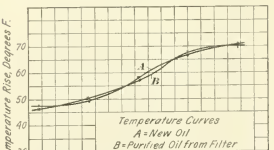


FIG. 2

The curves in Fig. 1 show the coefficient of friction of the new and filtered oils. The difference in temperature between the bearing and the room have been plotted in the curves shown in Fig. 2.

The system has been in operation for over a year and a half and the question naturally arises, what physical changes has the oil undergone during this period?

The results of tests made to determine this are shown in the curves of viscosity, Fig. 3.

It is evident that the oil has gained in specific gravity through constant use, as would be expected inasmuch as the oil, in passing through the bearings has had some of its more volatile constituents driven off, also a small quantity of cylinder oil used for lubricating the piston rods and stuffingboxes naturally finds its way into the oiling system. The viscosity curves show that the used oil has a higher viscosity than the new, clearly demonstrating that as oil is used over and over again in an oiling system it actually gains in body, provided, of course, the filter thoroughly removes entrained water, and this is the vital point of the whole system.

The results of the friction tests as shown in Fig. 1, are also consistent with these physical changes, as the new oil has a slightly lower coefficient of friction on low bearing pressures while the purified oil shows a lower coefficient on higher bearing pressures. This is due to the fact just noted.

The curves shown in Fig. 2 are the ones most interesting to the operating engineer, as it is usually by the temperature of the bearings that he determines the quality of lubrica-

tion. As will be noted, these curves are practically superimposed and in no case is the variation more than a few degrees so that here again it is proven that filtered oil is as good as new oil.

Referring to Fig. 3, it will be seen that if the oil is heated to a temperature of about 150°, its viscosity is only slightly higher than that of water, even after the oil has been in service a long time. Now, if oil at

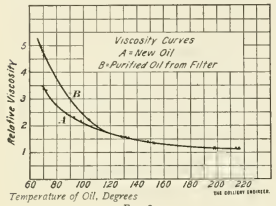


Fig. 3

this temperature could be spread out in a very thin film, entrained water and other impurities which are heavier than oil would settle out very rapidly. To accomplish this, the dirty oil is heated as it passes into the filter, after which it is carried to the bottom of a precipitation compartment where it is spread over an area of about 14 square feet though the compartment occupies but 2½ square feet of floor space. The velocity of the oil in passing through this compartment is reduced to .2 foot per second, which allows plenty of time for the precipitation. The importance of thoroughly separating entrained water from the oil is demonstrated by the fact that at this plant about 4 gallons of water per day are separated and ejected from the precipitation chambers.

The oil, after separation, passes to the filtering chambers, each of which contains 12 filtering units with a total area of 3.5 square feet. On this basis the filters are handling in a most efficient manner, 2.4 gallons of oil per square foot of filtering surface per hour.

The fact that a plant pays for less than two-tenths of 1 per cent. of the oil used and that oil can be purified in a commercial filter and returned to an oiling system in a state of purity equal to the new oil, is certainly of vast importance in the economical operation of power plants. The saving in the cost of the oil alone by the use of the oiling system in the plant picked for the tests is over $2,000 per month.

The data in this article were furnished by the engineering department of the Richardson-Phenix Co., Milwaukee, Wis.

International Study of the Coal-Dust Problem

Mr. J. Taffanel, mining engineer, former French Inspector of Mines and now the distinguished Director of the French Mine Experiment Station, at Lievin, is paying a visit to this country. He is known internationally for his original investigations of coal-dust explosions and means of preventing them. He is the guest of the United States Bureau of Mines, and is collaborating with Chief Mining Engineer George S. Rice, and others of the bureau's staff in special experiments at the bureau's experimental mine near Bruceton, Pa. Mr. Taffanel arrived in New York on April 22, and proceeded immediately to Pittsburg, where he has been busily engaged in the tests and in studying the records of past tests at the experimental mine, the final object of which is to diminish the danger of coal-dust explosions. While firedamp is a serious menace, its effect if ignited is in most cases local, if dry coal dust is not present to extend the explosion throughout the mine.

Mr. Taffanel's investigations, at Pittsburg and Bruceton, were interrupted by the news of the disaster at the Eccles mine, to which he went with Mr. Rice for an investigation. This is not Mr. Taffanel's first investigation of an American mine disaster. In 1907, on behalf of the French Association of Coal Operators, which has established the Lievin station as a result of the great Courrieres disaster in 1906, he came over to investigate the terrible Monongah disaster with 356 victims, and while here investigated the Darr mine and Naomi mine explosions. He has also investigated the large British mine disasters of recent years, including Hulton and West Hanley collieries and the very recent great disaster at the Universal colliery, at Senghenydd, South Wales.

Besides the explosion investigations, Mr. Taffanel carries on at the Lievin station tests of safety lamps, explosives, and mine-rescue apparatus and he has an organized crew of rescue men ready to visit any mine disaster in northern France.

In response to inquiry, Mr. Taffanel said: "I came to this country for the purpose of studying in collaboration with the Bureau of Mines and the Chief Mining Engineer, Mr. Rice, some questions concerning the danger of coal dust and the means of overcoming this danger.

"I began experiment on this subject in 1907, when the Coal Mine Owners' Association of France decided, some months after the Courrieres disaster, to organize the experimental station at Lievin. I have made up to date more than 1,400 explosions in an experimental gallery and have collected a considerable amount of data concerning the relative danger of many coal dusts or coal and stone-dust mixtures. Although the experiments are pursued on a big scale, in a gallery 1,200 feet long, the experiments at Lievin do not realize exactly the conditions of the mine, and the results must be checked by means of comparative tests in an actual mine. I made such tests last year, in an abandoned passageway of the Community mine, in France, but was obliged to stop after an explosion which destroyed a part of the passageway. In the course of 2 months, I will make tests of the same kind in another abandoned French mine at Montvicq. In the meantime, I was very glad to be invited by the Bureau of Mines to

follow the experiments in the Bruceton mine, which is perfectly equipped for such work. I find great profit in studying the very important results obtained in this mine by Mr. Rice. Moreover, the experimental comparison of the Lievin and Bruceton results is important as it gives a confirmation of the Lievin results under the real conditions of the mine. It allows to be taken into account the large amount of data obtained at Lievin for application to the Bruceton mine or, generally speaking, to the American mines.

"Some years ago, I designed the first form of arresting barriers which have proved, in many tests, to be effective for stopping coal-dust explosions. About 1½ years ago, I began studying new forms of arresting barriers, i. e., tanks or boxes, containing a great quantity of extinguishing materials (water or stone dust), which are automatically opened by the air wave preceding the flame. Mr. Rice has followed paralleled studies and we find great profit in collaborating for improving these devices in order to get the most practical and effective solution.

"The coal-dust problem is a very difficult problem of international interest. All countries which have undertaken to minimize this great danger must unite their efforts to obtain best results in the shortest possible time."

Natural History of Coal Dust

By E. B. Wilson

When the members of the Manchester Geological Survey visited the Lomax Laboratory, at Bolton, England, Mr. James Lomax delivered an address on the "Natural History of Coal and Coal Dust." One of the many interesting things that he said was "that one-half of the coal beds were made from lycopods or ground pines, and the remainder from ferns and calamites." Another was that "the ferns having quick growing propensities would form a vegetable humus sufficiently thick to allow the resinous ground pines to begin their reign, and it is from these resinous bodies that the most inflammable dust is obtained." While exceptions may be taken to this last statement, the one following is probably correct; namely, "that many coal seams give off a large amount of inflammable dust, according to the stratigraphical conditions, such as depth from the surface, moisture, etc., and the method of working."

Observations made over a number of years lead to the conclusion that bituminous coal with marked cleatage is more apt to crumble, air slack, and reach a fine state of subdivision, bordering on impalpability, than more cohesive coals with less pronounced cleatage. Coal which shows marked cleatage is usually good coking coal, and coals of this class which contain the least volatile matter, air slack, crumble, and create more dust than coal higher in volatile matter. The least friable coals are the resinous block, gas, splint, and cannel coals, which require extraordinary abuse to convert them into dust fine enough to explode. It is possible that considerable coal of this resinous type can be made so fine in mining, handling, and in transportation that it would readily distil gas to add to a conflagration, and even some might be so fine as to explode; however, the cleatage, fracture, and cohesion of resinous coals do not permit of their forming explosive dust anywhere near so readily as the less resinous coking coal or those with pronounced cleatage; hence, the exception to Mr. Lomax's statement. Usually the coals with pronounced cleatage are deep seated or have been subject to conditions when the coal was formed that prevented their becoming resinous and compact. It is evident, also, that this kind of coal loses moisture more readily than the compact resinous coals, a matter which hastens air slacking. In order to explode any kind of carbon dust, it must be impalpable powder, but flame from a blown-out shot or from an explosion of gas may distil gas rapidly from coal particles, and so continue a conflagration amounting virtually to a gas explosion. It is a comparatively easy matter to keep traveling roads free from dust where resinous coal is being mined, and sprinkling will be effective; not so, however, where friable coal is being mined, for its dust is so light and so readily made that it travels wherever the air circulates, and sprinkling has little effect, in fact, dust will coat drops of water; hence the necessity for furnishing steam to moisten the air, Taffnel dust shelves to stop the propagating of flames, solutions of hygroscopic salts to allay the dust, Kruskof troughs and swinging doors to cool and quench the propagating flame.

The New Owner of the Temple Iron Co.'s Collieries

The anthracite collieries heretofore owned and operated by the Temple Iron Co., have been purchased by S. Brinckerhoff Thorne, of New York City.

The collieries, six in number, are located in Lackawanna and Luzerne counties, Pa., and have a combined output of about 2,000,000 tons per annum. "Brinck" Thorne, as he is best known, comes from one of the oldest Knickerbocker families of New York City, where he was born about 40 years ago. He graduated at Yale University in the class of 1896. During his college life, he won distinction as one of the greatest amateur athletes of the country and was especially prominent in collegiate football. After graduating at Yale, he took a post-graduate course in mining at Lafayette College. He then went to Scranton, Pa., and with the object of obtaining practical experience he worked as a fireman on the Erie and Wyoming Valley Railroad, which was owned by the Pennsylvania Coal Co., in which his family was interested, and later he worked in the coal mines of the latter company. When the late George F. Baer, under the old Temple Iron Co. charter was instrumental in getting control of the six collieries, and they passed into possession of that company, he

appointed Mr. Thorne general manager of the company. Mr. Thorne then organized the working force of the company, which remains today practically the same. In the meantime his personal friend and college mate, James B. Neale, secured leases on a couple of anthracite properties, and Mr. Thorne resigned the managership of the Temple Iron Co. to join him in business. In addition to the anthracite collieries he and Mr. Neale went into the business of bituminous coal mining in Pennsylvania, and in the Northwest. About 4 years ago he went to New York City and established the firm of Thorne, Neale & Co. for the purpose of selling the output of the firm's collieries. This developed into a large and remarkably successful business.

By the acquisition of the Temple Iron Co. collieries Mr. Thorne controls collieries that have a larger annual production of anthracite than those of any other coal company, or operator, except the eight large companies, and he has become a very prominent factor in the anthracite industry.

He is a man of fine physique and most pleasing personality. Those who are fortunate enough to know him intimately hold him in high regard, and his subordinates recognize in him both a leader and a friend.

Be Careful of Carbide

An accident in the Sonman Shaft mine near Johnstown, Pa., should be a warning to users of carbide.

A miner carrying a glass jar filled with the carbide had arrived at his work in the mine when he let the jar slip and it was broken into many pieces on a rail. The carbide rolled into a ditch at the side of the track, where there was running water. The water generated acetylene gas, the light on the miner's head ignited it, and then came the explosion, and he was badly burned. Carbide should be kept in metal containers and away from water.

New Executives for Prominent Anthracite Companies

W. J. RICHARDS

William J. Richards, vice-president and general manager of the Philadelphia & Reading Coal and Iron Co., was elected president of that great anthracite mining company, in the place of George F. Baer, deceased.

W. J. Richards, President P. & R. C. and I. Co.

This election makes Mr. Richards' position that of president and general manager. He is peculiarly well fitted for the important position as he combines in his personality the qualities of an able mining engineer with a high degree of executive ability, and the faculty of organizing a loyal and competent corps of subordinate officials. Mr. Richards is a native of Minersville, Schuylkill County, Pa., and a graduate of the High School of that borough. As a young man he considered his public school education merely a foundation on which to build. For 3 years he taught in public schools, all the time adding to his preliminary education. In 1882 he entered the employ of the Engineering Department of the Philadelphia & Reading Coal and Iron Co., as a chainman on the corps having charge of the Shenandoah district, with headquarters at Ashland, Pa. He remained at Ashland until the early part of 1887, and notwithstanding the fact that the work of the corps entailed long hours and much night work, he kept up his studies.

In 1887, he resigned his position at Ashland to accept a position with the Mineral Railroad and Mining Co., at Shamokin, but later in the year, a vacancy having occurred in the Philadelphia & Reading corps that offered better remuneration, he was induced to return to the service of that company. In 1889 he accepted the position of chief engineer of the Lehigh & Wilkes-Barre Coal Co., at Wilkes-Barre, Pa., and he served in this capacity until 1898, when he was made general superintendent of the company.

In 1903, when the late R. C. Luther retired as general manager of the Philadelphia & Reading Coal and Iron Co., the late George F. Baer, who as president of both the Lehigh and Wilkes-Barre and the Reading companies recognized Mr. Richards' ability, tendered him the appointment of general manager of the P. & R. C. and I. Co.

Mr. Richards, with the knowledge gained by former service that Mr. Luther and his predecessors were somewhat handicapped by restricted authority, accepted the offer on condition that he was to be supreme in the management until the coal was in the cars under the breaker, and that he was to report to no one but Mr. Baer. Mr. Baer, one of the ablest executives of the day, recognized the necessity of such a policy, and Mr. Richards accepted the position.

In 1905, he was elected second vice-president of the company, and in 1908 first vice-president. In every position he ever held W. J. Richards "made good." He never arrived at the stage when he thought he knew it all, but no coal mining proposition, however complicated, was beyond his ultimate solution. If, when engaged in the details of mining engineering, he met a prob-

lem not previously encountered, he would remain up all night studying means to overcome it, and when daylight came he led his corps to a successful solution. He has not outgrown this habit as yet, and probably will not as long as he is engaged in mining. He has won position and distinction entirely through his own efforts, and that he richly deserved his various promotions is evidenced in every case by the records of his work.

CHARLES F. HUBER

Charles F. Huber, recently elected president of the Lehigh & Wilkes-Barre Coal Co., one of the six great anthracite companies, like W. J. Richards is a native of Schuylkill County, Pa., his birthplace being Pottsville. Mr. Huber graduated from the Pottsville High School in 1887, and in the same year entered the employ of the Lehigh & Wilkes-Barre Coal Co. as a chainman at Audenreid, Pa. In 1891, he was promoted to the position of division engineer at Audenreid, and in 1898, he succeeded W. J. Richards, who became general manager, as chief engineer, with headquarters at Wilkes-Barre. For 5 years he served under Mr. Richards as chief engineer, and when the latter accepted the management of the P. & R. C. and I. Co., he suggested to President Baer, the advisability of making Mr. Huber, whose ability and force he had proved, general superintendent. This position he assumed on October 1, 1903. In January, 1909, he was promoted to the position of vice-president and general manager, and on May 1 he was elected president of the company, vice George F. Baer, deceased. This election, to the presidency of the company, does not relieve him of his duties as general manager. He will retain his managerial position, as well as assuming the executive position. Mr. Huber, like Mr. Richards, whom he succeeds, has won success entirely through his own efforts and development of ability in the school of hard practical experience.

Neutral Coke—Diehl-Faber Process

*By J. R. Campbell**

At one of the meetings of the eighth International Congress of Applied Chemistry†, Mr. J. R. Campbell read a paper on "Neutral Coke," detailing the tests made at the Gary, Ind., by-product coke oven plant.

CHARLES F. HUBER, PRESIDENT LEHIGH & WILKES-BARRE COAL CO.

The object of the tests was to investigate the claims made for the Diehl-Faber process, which were that if limestone was introduced into a charge of raw coal containing sulphur, the sulphur would combine with the lime and form calcium sulphide during the coking process and improve the physical quality of the coke. During the investigations, data were secured concerning the effect the limestone had on the gases and ammonia yield, and also what temperature must prevail to secure the desired results. The conclusions which Mr. Campbell reached are as follows:

1. That the temperature of the coking mass is insufficient for the complete transformation of sulphur (*S*) in the coal to *CaS* in the coke during the coking process, and that such temperature must be over 2,100° F., and perhaps will be near 2,500° F.

2. That the temperature is insufficient for the complete formation of lime silicates, as evidenced by the free lime (*CaO*) in tests 2 and 3.

3. That it is not practicable to use more limestone than will combine with the ash of the coal to form a monosilicate, as evidenced by test No. 4.

4. That the physical quality of the coke is improved by the limestone additions, if too much free lime (*CaO*) does not remain in the coke and if such additions are for the formation of a monosilicate, as evidenced by the physical tests of the coke and its physical appearance, provided, always that high temperatures prevail at or near the close of the coking process.

5. That the decomposition of the limestone and the action of the resultant carbon dioxide (CO_2) on the incandescent coke, forms high percentages of carbon monoxide (*CO*) gas, which lowers the British thermal units value of the whole gas about 10 per cent.

6. That it follows naturally from 5, the percentage of yield of neutral coke is probably lower than the run-of-mine coke, tests No. 2 and No. 3 showing between 1 per cent. and 2 per cent. lower yield on an average than test No. 1.

7. That the coking time will be extended by the introduction of limestone into the charge, if any beneficial results are to be expected, as shown by tests No. 1 and No. 3.

8. That the total ammonium (NH_3) yield will be increased quite materially as evidenced by bomb tests.

9. That to attain sufficiently high temperature in the coking mass for the desired chemical reaction and permanent physical qualities in the coke, will necessitate maintaining the oven flues at critical temperatures, say, 2,700° to 3,000° F.

10. That the Diehl-Faber process has but little practical value from a blast-furnace standpoint, unless all the sulphur is converted to calcium sulphide (*CaS*) during the coking

*Scottdale, Pa.
†Volume X, page 73.

process, or unless a silicate is formed, for the reasons that sulphur (*S*) other than in calcium sulphide (*CaS*) will enter the iron readily, and that the free lime (*CaO*) will cause the coke to crumble upon exposure to the atmosphere.

Saline County First-Aid Meet

With the indorsement and cooperation of the Illinois Mine Rescue Commission, the Saline County Mine

View of Grounds and Gallery, Saline County First-Aid Meet

Safety Association held its first annual rescue and first-aid contest, on May 2, at Harrisburg, Ill.

Before the exercises commenced there was a parade, after which the mayor delivered an address of welcome to which Prof. H. H. Stoek replied on behalf of the Illinois Mine Rescue Commission.

Facing the grand stand at White City Park, was a miniature shaft mine with one entry, from which four rooms were turned. One side of this entry with the exception of the ends was open, so that spectators in the grand stand were able to see the work in three rooms, the fourth room away from the shaft being enclosed. The fire boss was shown making his rounds, testing for gas and loose roof rock. When he found weak roof he either took it down or marked where timbers were to be placed. Just past No. 3 room he found gas and marked a warning. He then went from the mine and gave his report to the foreman.

The miners were next seen going to work with their buckets; they got their checks and entered the mine. In room No. 1 they commenced cutting coal with a Goodman breast machine run by electric power. In room No. 2 the men stood props; in room No. 3 they were loading coal, while in the entry, men were seen laying track and timbering. At the end of the entry, men were arguing with the boss on the feasibility of putting off a shot, and finally it was set off and caused a dust explosion. The day was ideal and the wind right to blow the smoke from the explosion the entire length of the gallery. Those men nearest the shaft threw down their tools and worked through the smoke toward the seat of the explosion. They removed two victims and reported the conditions as bad inside, thereupon the foreman telegraphed the Illinois Rescue Station, who immediately sent a car to Harrisburg. Automobiles met the car and carried the helmet men, with their apparatus, to the mine. The cars could be seen coming around the race track, and their approach was watched with interest.

On reaching the mine, the men put on their apparatus and went inside a smoke room to test it before going into the mine. Mr. Cartlidge was taking no chances with his men when going into this miniature mine. On entering the mine, the leader of the helmet men payed out the life line and the others followed after. The rooms were explored and a man was found overcome in the entry. The crew assembled, and with the aid of the Hubbell lamps that they carried were able in the smoke to place the man on a stretcher which two carried from the mine, while the others explored further. Another man was found and carried out, until five in number were recovered and resuscitated by the first-aid corps working in front of the grand stand. Three of the victims were so badly injured that a call was sent for ambulances and a doctor. Around the track came an ambulance with the horses on the run, a short distance behind came an automobile ambulance, and after a few minutes another ambulance with the horses galloping.

The injured were placed on stretchers and put in the ambulances, while the man pronounced dead by the doctor, was placed in an undertaker's basket. To make the scene more sad and add pathos, the band softly doled "Home Sweet Home." All that was needed to complete the scene and inflict the "willies," was a few women and children crying. Men who have attended meetings of this kind in various states and have also been where real explosions have occurred, stated that for realism, the play could not have been better acted.

After lunch the grand stand and every available place of vantage where a person could see over the heads of those at the ropes was occupied, in fact, many were unable to see the two first-aid events.

Event No. 1 was for one man. The first prize, gold medals, was won by John Kranock and his subject, Charles Elliott, of the Bunsen Coal Co., Westville. The second prize, went to John Griffith and his subject, Matthew Dewar, Jr., of Cuba. The third prize, silver medals, for both the operator and subject, was awarded to James

Struthers and his subject, Daniel McLaughlin, of Gillespie.

The five-man event was won by the Superior Coal Co.'s team, composed of James Weir, captain, James Struthers, Charles Miller, John Cowdin, and Robert Weir. These men won a silver cup presented by the Saline County Mine Safety Association, and on it the names of the winners will be engraved; also medals from the American Mine Safety Association, and gold medals were also presented to each member of the team.

Second prize, gold medals, was won by the Bunsen Coal Co.'s team, J. H. Kranock, captain, Stephen Shaffer, Stephen Tobey, Joseph Deborah, and C. E. Noonan.

Third prize was won by the Carterville Coal Co., of Herrin. The men who received silver medals were Oscar Horn, captain, D. H. Wilson, Clark Miller, Thomas Thorton, and T. F. Bailey.

The judges of the contest were:

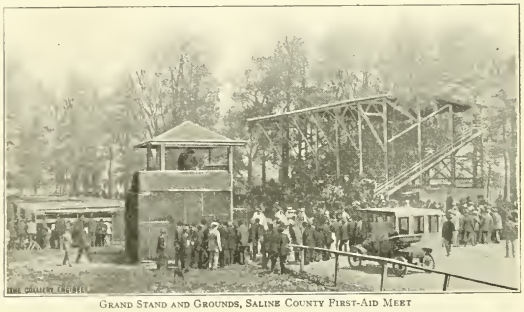
Dr. A. F. Knoefel, Terre Haute, Ind., vice-president of the American Mine Safety Association; Dr. H. C. Blankenship, Springfield, Ill.; Dr. Frank Deason, Bush, Ill.; Doctor Clatfelter, Hillsboro, Ill., and Dr. J. A. Orr, La Salle, Ill.

Doctor Knoefel distributed the American Mine Safety Association prizes; William Johnson, president of Saline County Mine Safety Association, presented the cup, and James Kelly, vice-president of the 7th Sub-District Illinois, U. M. W. of A., presented the gold and silver medals.

This most successful meet was due to the work of Oscar Cartlidge, manager of the Illinois Mine Rescue Stations, and to J. R. Henderson, of the Saline Coal Co.; C. A. Horning, chief inspector O'Gara Coal Co.; W. L. Taylor, George Tinsey, miners; George Riggs, of the Bureau of Mines, and Mr. Lee of the Illinois Miners and Mechanics Institute. Everything combined to make this meeting the most successful, instructive and entertaining affair of the kind ever held in Illinois.

In the evening Dr. R. Y. Williams, Director of Illinois Miners and Mechanics Institute was to have given a lecture on "Mine Safety" aided by moving pictures; unfortunately, he was taken sick on the train, and Mr. Lee, his assistant, located at Harrisburg, substituted exceedingly well. Mr. W. G. Ryan, of the Bureau of Mines talked interestingly on the Bureau of Mines work.

Shot firing had taken place in the new heading the previous day at 6:30 P. M., and on the following morning the work of removing the fallen rock, etc., was continued, fresh bore holes were drilled, and preparations made for further shot firing. Meanwhile the place had been reported free from firedamp, and the ventilating arrangements were in perfect order. About 1 P. M.,



Grand Stand and Grounds, Saline County First-Aid Meet

Explosion at the Oberhausen Colliery, Germany

On July 3, 1912, shortly before 1 P. M., toward the end of the morning shift, an explosion took place at the Osterfeld, I-III Pit (Westphalia), of the Oberhausen colliery, resulting in the loss of 16 lives, and severe injury to seven other persons.

The disaster occurred at the 1,919-foot level in a heading driven from the Mathilde seam (workable thickness, 3½ feet) to the overlying unworkable Mathias II seam; both of these seams belong to the Upper Bituminous coal group, dip southwards some 12 degrees, are gently undulating, and much fractured by faults. The seams were not regarded as fiery, but they are very dusty; accumulations of firedamp of any consequence had not been recorded in the workings, and vigorous spraying was enforced to minimize the danger arising from the coal dust. On the day of the disaster a rising barometer showed an average height of 755 millimeters (29.145 inches).

just after the head shot firer had gone down from the upper level to the new heading, a sort of muffled roar was heard, followed by tremendous blasts of air and long sheets of flame. The dynamic effects of the explosion were comparatively restricted; even the double-gauze lamps carried by the victims were, with one exception, practically undamaged.

There appears to be no doubt that the explosion originated from shots fired with an excessive number of dynamite cartridges and a time fuse by two pitmen who were among the killed; and the men responsible for this had knowingly contravened the regulations in order to bring down more coal at a time and probably thus save time or earn more money.

When stripping ground or blasting deep holes from the surface, it is safer and more economical to use two exploders in each hole, for it is practically impossible to dig out a 20-foot or 30-foot hole, put down by a drilling machine.

Big Business and Mining

The Question of the Regulation of Competition, the Regulation of Monopoly, or the Regulation of Cooperation

By Charles Richard Van Hise*

IT IS desired, that I discuss the trust problem in its broader relations and particularly in relation to mining.

It is curious that the larger part of the discussions regarding trusts during the past 2 years, clustered about a phrase invented by Mr. Louis Brandeis. He said: "The question before the people is, the regulation of competition *vs.* the regulation of monopoly." The phrase struck popular fancy, and was accepted as a correct statement of the trust problem, however, no such necessary alternative is before us at the present time. There are many other solutions than regulated competition or regulated monopoly. The scientific mind demands not that two of the various possible solutions be considered, but that all be taken into account, and the best one selected.

In the discussions of the trust problem, magnitude and monopoly in industry have been treated as synonymous terms. There may be great magnitude in a business, and not monopoly. Indeed the greater number of large organizations fall short of monopoly; but it has been tacitly assumed in most public discussions that all are monopolies. Only if we assume that all of the great concentrations of industry are monopolies, does the statement of the question as regulated competition versus regulated monopoly correspond with the problem.

It is generally agreed, that concentration of industry up to a certain point is necessary in order to give efficiency. It would not be held by any one that we should return to the situation of 50 or 60 years ago, in which there were few organizations of large size, but many minor organizations scattered all over the country. To return from the great flour mill to the cross-roads grist mill is impossible. This illustration shows that some degree of concentration is allowable. The practical question is: What degree of concentration is permissible and advantageous, not only for economy in production, but for the people at large? It is therefore clear that it does not meet the question to assume that all of the concentrations of industry are monopolies. If we can make that assumption and place it as the foundation stone of our argument, it is easy to win approval of the idea of regulated competition.

Monopoly has never been recognized in this country by law; neither has it been so recognized in England. Cooperation in industry both by combination and by contracts has been recognized by the laws of both countries. The distinction is fundamental. The laws in regard to combinations and contracts in restraint of trade went through a similar evolution both in this country and in England, and the laws finally became very liberal. By gradual development the principle has been reached that freedom in trade means freedom to combine as well as freedom to compete. This was the situation in this country also when in 1890 the Sherman law was enacted, and immediately the wheels, so far as cooperation was concerned, were turned back to the conditions of the Middle Ages. All combinations and contracts in restraint of trade were prohibited, and this applied to the latter, even if limited in extent or confined in time. This national legislation led to an influenza of similar legislation in the states and, within a few years, more than 30 states had passed statutes against combinations and contracts in restraint of trade, many of them even more drastic than the Sherman law.

The Sherman act contained two separate provisions, one of which prohibits every contract and combination in the form of trust or otherwise in restraint of trade as illegal; another section provides that monopoly or attempt to monopolize is also illegal.

By the public it was supposed that every contract and combination in restraint of trade meant what the words said, and that Congress in using these words meant to pass a new and drastic law replacing the common law; indeed the earlier decisions of the Supreme Court took this point of view and held that the reasonableness or unreasonableness of a contract or combination was immaterial. However, in the Standard Oil and Tobacco cases the court took an entirely new attitude and stated that only restraint of trade which was undue was meant to be covered by the law (although the word "undue" is nowhere in the act), that the restraint meant was that which was not permitted under the common law; and, therefore, that only contracts or combinations were prohibited by the law which were unreasonably in restraint of trade.

I do not know why this change in front was made; but it is a fair conclusion that the investigations of the Supreme Court led them to the view that if the Sherman act were enforced in accordance with its terms prohibiting all contracts and combinations in restraint of trade, this would create an impossible situation. Therefore, they inserted the words "undue" or "unreasonable" into the law, so as to make it as nearly as possible in accordance with common law; and thus started a second cycle of development by judicial decision in order to make it approach, as nearly as possible, to the common law which existed before the act was passed.

While these recent decisions of the court do not go far enough, they clearly point the way to a ground intermediate between "regulation of monopoly or regulation of competition," and this is: Freedom of competition, prohibition of monopoly,

*Abstract of an address delivered before the sixteenth annual session of the American Mining Congress, held in Philadelphia, Pa., October 22, 1913, entitled, "Big business in its relation to industrial prosperity with particular reference to mining."

permission to cooperate, and regulation of cooperation. As already noticed, if it can be assumed that the above phrase contains all of the possible alternatives, it is easy to reach a conclusion. We must not have monopoly and therefore we are driven to the other conclusion—regulation of competition; but since the assumption is fallacious, the conclusion has no foundation.

We have gone through one stage of development, and have made the first step in the second stage. It is now proposed to neutralize the decisions of the court by defining "reasonable" so that it shall mean prohibition of all contracts and combinations in restraint of trade, and thus succeed in getting statute law back to where Senator Sherman and the people thought they had gotten it 30 years ago through the enactment by Congress of the Sherman act. This would compel the beginning of another third cycle of development.

In regard to the Sherman act, it has been assumed that its only violators are the great combinations. The Steel Trust, the Tobacco Trust, and a few other large combinations are mentioned; and it is supposed that the small business men and the small producers are not acting in violation of the law. But the principle of cooperation which the Sherman act tries to suppress extends from the great industrial centers, like Philadelphia, to the country cross-roads. Does it make any difference here in Philadelphia, whether one buys anthracite of one retail dealer or another? It doesn't make any difference in the country cross-roads either. The price is just the same from all the dealers in the same locality. The same is true of ice, and is also true of all standard articles. The principle of cooperation has extended from the great manufacturers and the great dealers of the large cities to the small manufacturers and small dealers of the small cities and even villages. All are cooperating in exactly the same way; the principle is the same for the large and small men, one is violating the law just as certainly as is the other. I am willing to stand for enforcement of law when the law is enforced alike for all; but when somebody is picked out because he is in the front seat, or because it is good politics to attack him and ninety-nine or nine hundred and ninety-nine are allowed to escape I say that it is a profoundly immoral situation. And that is exactly the existing situation in this country. The politician who says "Break up these trusts; destroy them," says with the very same breath: "We must have cooperation among the farmers."

Why, gentlemen, the cranberry growers of Cape Cod, New Jersey, and Wisconsin, sell about 90 per cent. of their products through an agency down in Hudson Street, New York. Similarly, many products of the farmers, illustrated by cotton, citrus fruits, etc., are marketed through cooperative selling agencies. Have we heard of the Attorney-General prosecuting these farmers? Congress understands the situation and at their two recent sessions they attached to the sundry civil bill a clause containing an appropriation of $300,000 for the enforcement of the antitrust laws, which included the provision that none of this money should be spent in prosecuting combinations or agreements of labor, nor spent "for the prosecution of producers of farm products and associations of farmers who cooperate and organize in an effort to and for the purpose to obtain and maintain a fair and reasonable price for their products."

The purpose of this provision is clearly to make the Sherman law class legislation by indirection and, in effect, to prevent equality before the law of the manufacturer as compared with the farmer. Also, some of the smarter state legislatures have seen the situation, and in order to prevent the farmers from being hit by their antitrust bills exempted the products of the lands so long as in the hands of the producers. This was true for Texas, Louisiana, Illinois, and South Dakota. You see the state legislature, like Congress, saw that the farmers have so many votes that they have to be dealt with gently when they form a trust.

But some of the state laws got into the United States courts, and these courts promptly declared these exemptions unconstitutional as being special legislation, and not giving equal protection under the laws. I venture to predict that it will not be so popular a political game to shout, "Bust the trusts" when the farmers understand that their trusts are also to be "busted."

No more pernicious or immoral legislation was ever passed by Congress or by the states. Fortunately ex-President Taft and President Wilson have both protested against the pernicious action of Congress. The principles of justice in regard to trusts and combinations are alike for the manufacturers, the farmers, and the laborers.

In this country we have not a special situation which concerns a few men, but a general, irresistible impulse. It is all very well to ask, "Has the time come when a few rich men shall defy the law?" but Edmund Burke said more than a century ago, "I do not know the method of drawing up an indictment against a whole people." And that is the situation which we have in this nation as regards combination. There is just as close-riveted an arrangement between the three icemen in the country town as there is in steel; and any solution of the problem of combination, if it be a just solution, must be applied not only to steel, tobacco, etc., but to the small tradesman and the farmer. Just as certainly as the great combinations are violating the Sherman act, as I have no doubt many of them are, so are the small aggregations of wealth violating state antitrust statutes. This general violation of the trust laws, national and state, is the problem that we have before us.

The tendency for cooperation in this twentieth century is so much stronger than the tendency for competition, that the latter will never be restored in the old sense. There will be competition between different classes of goods; there will be

competition between the great mail-order house and the village grocer; there will be competition in service; and I am just as anxious as any one to have trade regulated by competition as far as possible; but, as a matter of fact, competition has broken down hopelessly in this country to adequately control prices; to adequately control quality; and we all know it.

We have recognized the failure of competition to secure quality, by the establishment of the pure food laws. Why should we have pure food laws if competition will give us good quality? If articles were fraudulently sold, so important to the general welfare as foods, there was a remedy in the courts. If I were sold a thing as pure strained honey, that was wholly innocent of having any relation whatever with a bee, I had a remedy in law; I had been fraudulently dealt with. Why didn't I take my case to the courts? You know why. The loss was so small that it was impracticable for the individual to thus obtain redress. Finally, recognizing the fact that competition was wholly inadequate to secure pure food, national and state pure food laws were enacted and special officers were designated upon whom was imposed the duty of protecting the public. When we confessed that competition did not regulate quality, and imposed the duty of protecting the public upon administrative officers, we succeeded in getting pure food, or a reasonable proportion of pure food, at least, and never until then.

This brings us to the next point of the discussion—the forces which have led to combination in this country. Each step from the loose association to complete merger was taken to escape the last decision of the court because of the irresistible tendency for cooperation. Other forces which have led to combination are the desire to eliminate or at least restrict competition, the desire to limit output and divide territory—and in connection with these the maintenance of prices. These forces may be legitimate or illegitimate, depending upon the extent to which they are carried. Another force strongly influential in producing concentration has been the profit of promoters. Regarding the legitimacy of this force there may be great doubt in many cases. Limited time, while permitting the enumeration of these forces, prohibits their adequate discussion; therefore I shall pass on to the advantages which result from cooperation, and especially with relation to the natural resources.

There can be no question that the competitive system, when unrestrained, is positively opposed to the policy of conservation. This is true alike for minerals and timber, but tonight I can only consider the first aspect of the subject.

The minerals of the earth, and here are included not only the metallic minerals but the carbon compounds, required the building of the earth for their making. Mineral deposits are doubtless in the process of manufacture at the present time; but even if so, this is at so slow a rate as to be negligible. From the point of view of mankind, the stores of minerals in the earth are deposits of definite magnitude upon which we may draw but once and which by no possibility can be increased. To illustrate, with regard to the banks of coal, the situation in regard to this subsurface produce of first importance for the human race is similar to that of a man who has a deposit in a bank upon which he may draw, but can not by any possibility increase by a single dollar. He is obliged to make his existing bank account last throughout his life. Similarly the mineral resources of the earth must last throughout the life of humanity.

In this connection it should be recognized that modern civilization would not be possible without the mineral resources of the earth—no iron ships, no metal agricultural implements, no tools except those of stone, no fuel but wood. Without the subsurface products of the earth we would at once return to the material conditions of the stone age.

It is therefore incontrovertible that, from the point of view of the human race, economic systems or laws which result in unnecessarily rapid use of the mineral stores of the earth are indefensible; but such are the economic theories and laws now dominant in the United States. The wastefulness of the competitive system may be proved with regard to every product which is taken from the earth. In a single address this cannot be done, but I shall mention coal to illustrate the truth of the above positions.

The most disastrous losses in the mining industry, so far as the future of the human race is concerned, are in connection with coal. Holmes, in a paper upon mineral wastes, says that in the early days of mining, when there was much subdivision of ownership, that not more than 30 to 40 per cent. of the anthracite coal in the veins mined was brought to the surface, leaving from 60 to 70 per cent. in the ground. He states that even at the present time not more than 50 per cent. of the anthracite reaches the surface.* The situation is similar for bituminous coal, but until recently the losses for such coal were substantially half. This loss has been somewhat reduced, but it continues to be appalling. The principles which from the point of view of conservation should apply to mining of coal are well known. So far as practicable the mines should be so worked as to make one superimposed bed after the other available. Coal slack should be reduced in amount and should be utilized. No considerable percentage of coal should be left in the ground as pillars. If these reforms were introduced, the loses could be reduced to half the present amounts and possibly to one-fourth.

But to ask that any such proposals should be put into operation under the restrained competitive system is purely chimerical. Under the Sherman law there is no opportunity to limit output, divide territory, or regulate prices. Five thousand bituminous coal operators could produce two hundred million tons of coal per annum beyond present

*Holmes is wrong.—Editor.

demands. If the operators could agree upon limitation of output and division of market, so as to reduce freights, and could arrange for reasonable prices which would give them no more than their present profits, they would then be able to follow these principles in mining their coal; for they themselves would be gainers in prolonging the life of their mines, and, far more important, many future generations would be the immeasurable gainers in that they would have adequate coal supply.

It is doubtless true that the proposed plan would result in somewhat higher prices for bituminous coal; but, even so, coal would be cheaper in this country than in others. This slight additional increment, however, would be but a small social burden for this generation to bear in order to leave an adequate heritage to future generations.

Under the competitive system, we are recklessly skimming the cream of the natural resources of a virgin continent with no regard for the rights of our children or our children's children. They will have a heavy score against us if we continue to ignore the future and to apply the unrestrained competitive system in total disregard of their rights.

In the time that remains to me I shall proceed to the constructive side of the question before us and make positive proposals in regard to the things which should be done in order to obtain the advantages of concentration of business and at the same time protect the public. My proposal, gentlemen, is neither regulated competition, nor regulated monopoly, but retention of competition, prohibition of monopoly, permission for cooperation, and regulation of the latter.

It has been proposed that combinations should be so divided that no one corporation shall have more than 0 per cent. of any business. That is Mr. Bryan's suggestion. In the case of the Stanley bill the presumption of the violation of the Sherman law is against a corporation having more than 30 per cent.

Now, it makes no difference whether you break the great combinations up so that no one combination has more than 50 per cent., or 30 per cent. of a line of business, or so that there are ten with 10 per cent. or twenty with 5 per cent. The demonstration of this lies in the fact already mentioned that thousands of farmers may and do cooperate in marketing their products just as perfectly as do the five great manufacturers of steel. This they do in various parts of the United States for numerous products. At the present time there are state and national movements to still farther extend the advantages of cooperation to the farmers. Since it is unquestionable that the sense of justice of the citizens of the United States will support the courts in prohibiting class legislation, we shall, therefore, I believe, ultimately permit cooperation in all lines of business alike. If we, however, retain freedom of competition, permit concentration sufficient to give efficiency, allow reasonable cooperation, and prevent monopoly, this will require regulation just as it has been necessary to regulate the railroads.

I have not time to more than touch upon necessary modifications of the law; but the substance of my remedied proposal is that there be an interstate trade commission and state trade commissions, which shall have substantially the same powers to regulate cooperation in industry that the Interstate Commerce Commission and the State Commerce Commissions have in regard to the public utilities. It seems to me that the Interstate and State Commerce Commissions and the administrative bodies for the pure food laws point the way for the next constructive step in the development of the laws. It would perhaps be chimerical, with public opinion as at present, to propose the repeal of the Sherman act; but the situation may be met by amendments to this law. The Sherman act can be left to apply, as defined by the Supreme Court, to monopoly. Unreasonable restraint of trade may be defined as monopolistic restraint of trade, and it is rather generally agreed that monopoly should be prohibited. To make the matter perfectly clear another amendment should allow reasonable cooperation, but such cooperation should be under the watchful eyes of administrative commissions in order to protect the public.

The coal operators at a conference held in Chicago in May, 1912, agreed upon a bill for the establishment of an interstate trade commission. The important power proposed for such commission was the authority to decide whether any proposed arrangement is in opposition to the Sherman act as it now exists under the interpretation of the courts. If any arrangement is approved by the commission as in accordance with law, then the organization which enters into such an arrangement is to be free from prosecution under the Sherman act. Also, the commission is empowered to require the discontinuance of any existing trade arrangement, practice, or combination which is found to be in violation of the national trust law.

From the foregoing discussion it is apparent that while the above proposal is a move in the right direction and is an improvement upon the present situation, it is not adequate. The frightful wastes of unrestrained competition as applied to mineral products, and especially as applied to coal, can only cease when operators are permitted to cooperate in limiting and dividing the market. However, if they are permitted thus to cooperate, there is danger that the public may be required to pay unreasonable prices; and therefore any such cooperation should be under the watchful eyes of commissions that should have power to require the discontinuance of any trade arrangement found inimical to the public welfare.

Ultimately also, it will probably be found necessary to give the commissions the same authority in regulating prices that the State and Interstate Commerce Commissions have in regulating rates for the public utilities. The burden of fixing prices should rest with the operators; but

whenever any man feels that a price is unreasonable, he should have the right to have his case brought before a commission for adjudication. If, after investigation, any price is found to be unreasonable, the commission should have authority to issue an order that it be made reasonable.

I am aware that the above suggestion regarding price regulation has been vigorously attacked; but it should be understood that the proposal does not involve the initiative in fixing prices. Wherever a business is not so large as to be affected by a public interest, the principles of trade which are now in force would hold in regard to prices; and this statement means that the great majority of prices would be controlled by the present system, as imperfect as it is. However, wherever cooperation and combination are permitted in such a manner as to lead to a situation where the market is controlled, it is clear that the public cannot be protected under these conditions unless represented by some authority having power to protect it, even to the extent of regulating prices.

The proposed trade commissions should have a number of other powers which I have not time fully to discuss. It is clear that all unfair practices should be prohibited; and by unfair practices is meant to include everything covered by the term immoral practices under the common law. If I were to define unfair practices, it would be that they should include all those practices of every kind which are inimical to the welfare of the people.

Another, and perhaps the most vital, point of the law creating the state and interstate trade commissions should be that when an individual is wronged through unreasonable rates, or rebates or other discrimination, it should be the duty of a public commission to handle his case. The aggrieved individual should not be obliged to carry his case through the machinery of the courts; he should make complaint to an administrative commission, representing the public, and him as a part of the public, to secure redress. This, while the greatest, is but one of the many advantages which may be gained through the establishment of trade commissions, national and state. The powers of the commissions should be granted as broad, simple rules of law; and detailed regulations for the administration of these rules should be formulated by the commissions.

If the views which are here presented are sound, it is clear that it is not sufficient simply to create trade commissions who shall act as interpreters of the Sherman act, but that important amendments to the Sherman act are necessary in order to permit the magnitude necessary for efficiency, in order to allow the cooperation imperative for conservation, in order to protect the public.

I do not suppose that at the outset the commissions created will receive all the powers which they will finally possess. Indeed, while I hold to the above principles, at first I should be conservative in giving powers to these commissions. The powers would be based upon the same principles that have been applied in the pure food laws, and in the control of the public utilities. The American people always move slowly in these matters, and step by step; and I should not expect that these trade commissions, if created, would at once be granted all the powers which they would finally exercise.

The Interstate Commerce Commission had small powers at first, merely powers of recommendation; and it was only 6 years ago that this commission finally gained the power to fix maximum rates; and at the present time the Commission have not the power to initiate rates. The initiative rests with the railroads. It is only 2 years ago that the Interstate Commerce Commission gained the power to suspend advances of rates pending investigations regarding their reasonableness. Thus, stage by stage, conservatively, the development of the control of public utilities by administrative commission was worked out.

Substantially the same history applies to the pure food laws. Doubtless the extension of laws of this class will go on until fabrics are included; until fraud will be practically eliminated through the use of false names for any commodity.

I would have the proposed trade commissions pass through a similar history. Thus, precisely as with the Commerce Commissions, by slow development, industry where cooperation has so extended as to become affected with a public interest would be controlled by trade commissions under the same lawful methods that have been applied to the public utilities. Concentration, cooperation, and control are presented as the keyboard to the solution of our great industrial problems.

A Successful Miners' Course

The College of Mines and Metallurgy of the Kentucky State University has met with success in its Practical Miners' Course held at Lexington, Ky.

The course opened as an 8-weeks term in the summer of 1908 and a fee of $10 was charged. During the summers of 1909, 1910, 1911, and 1912 it was a 10-weeks course, but in 1913 it was changed back to 8 weeks. The course opened April 1, this year, as an 8-weeks term with the fee discontinued. Starting with 12 men in 1908, the class increased in numbers with 34 matriculates in 1913 and 45 this term. Once matriculated, a miner is almost certain to stay through to the end of the term. Not a man has been lost this term.

These 45 men represent fifteen counties in Kentucky, while men have attended the course from Illinois, Iowa, Pennsylvania, West Virginia, and Tennessee. Nearly every class has had from one to three men who attended the course before and passed the mine foreman examination; two of the present class covered the course before and hold mine foreman certificates but they consider it worth while to repeat the work. This emphasizes the success of the course in winning and holding the men.

The course is under the direction

of Prof. C. J. Norwood, Dean, while the greater portion of the teaching is done by H. D. Easton, professor of mining engineering. The method of teaching is by blackboard talks and by the use of charts and apparatus. No text is used. Arithmetic and chemistry are mixed with the subjects they directly apply to; work in arithmetic is followed up all through the course. Instruction is given from 4 to 6 hours each day covering the following subjects:

1. *Coal Mining.*—(*a*) The different systems. Laying out the workings. Methods for thin and thick, and for flat and pitching beds. Management of squeezes, etc.

(*b*) Mining and blasting. Various explosives. Evils from improper blasting. Dangerous and safe methods. "Safety" powders, etc.

(*c*) Supporting excavations, including the principles underlying timbering, the different methods of timbering, computing the strength of pillars, etc.

(*d*) Ventilation. Methods of obtaining ventilation and of coursing, splitting, and regulating the current. Measuring the ventilation: use of anemometer, water gauge, etc. Study of furnaces and fans.

(*e*) Haulage and drainage.

(*f*) Sinking shafts and slopes. Safety appliances for shaft and slope mines.

2. *Mine Gases and Testing.*—(*a*) Nature and origin of each. Indications of the presence of each. (*b*) Testing for explosive and inexplosive gases. Principle of the safety lamp, and various types of such lamps. Use of safety lamps, etc.

The instruction in mine gases is illustrated with experiments, and the effect of different percentages of marsh gas on the safety lamp flame is shown.

3. *Explosions and Fires.*—The various causes. Relation of coal dust to explosions, and the management of dust. Relation of blasting to coal dust and other explosions. Demonstration of coal-dust explosion. Prevention of explosions. Causes and management of fires.

4. *Surveying and Map Drawing.* Use of compass (or of transit, as the case may be); putting up sights, marking off rooms at various angles, grading track (use of level), laying out curves, etc. Drawing the mine map. Men may devote all of the course to surveying if they so desire.

5. *Use of Mine Rescue Apparatus.* The different types of apparatus. Practice in use of the Draeger oxygen helmet, and of the "Pulmotor" reviving apparatus.

6. *Kentucky Mining Law, and the Duties of a Mine Foreman.*

7. *Geology.*—How coal is formed. Faults, etc.

8. *Chemistry.* — Elementary chemistry is taught along with explosives, mine gases, etc., but is not handled as a separate subject.

9. *Arithmetic.*—Attention is given to arithmetic from the very beginning and much instruction is given the individual. This subject is mixed all through the other subjects.

At the close of the term, each man who has completed the course in a satisfactory manner is given a university certificate showing that fact. These certificates are issued by the authority of the Board of Trustees, bear the university seal, and are signed by the president and the dean of mining.

Funds have not been available for carrying on extension work, not even for traveling expenses. However, cooperative extension school work is being done by the College of Mines and Metallurgy and the State Y. M. C. A. at Jenkins, Ky., and special university certificates are given to the men who do satisfactory work in this extension school. It is probable that traveling expenses will be provided by the university so that next session will find these extension branches at all points where the Y. M. C. A. has a Miners' Branch.

Practical Miners' Reunion, Lexington, Ky.

Practical Miners' Reunion.—A practical miners' reunion was held in Lexington on May 8 in connection with the annual meeting of the Kentucky Mining Institute. A Practical Miners' Association was organized and plans laid for annual reunions of the men who have attended the course. The accompanying photograph shows the men who attended this first reunion.

Coal miners probably average more working days in a year than men in other industries, unless it be iron and steel workers. In 1912, West Virginians worked 266 days; New Mexicans, 274 days; Utahians, 285 days; Texans, 299 days.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Open Lights in Well-Ventilated Mines

Editor The Colliery Engineer:

Sir:—I would like to see the opinions of various readers of The Colliery Engineer on the subject of the open lamp and its advantage over the Davy lamp from a safety standpoint.

At first glance this looks ridiculous, but it will be remembered that the danger from bad roof is minimized with an open lamp, owing to the greater illumination.

Assume that the mine generates some little firedamp, but is well ventilated. Mining Engineer

Pittsburg, Pa.

Qualifications for Certificate in Alberta

Editor The Colliery Engineer:

Sir:—I wish to inform your correspondent, Andrew Barclay, Bankhead, Alta., writing in your issue of The Colliery Engineer, May, 1914, that the standards of training and examination for first-class certificates in Alberta are on a level with those of Great Britain, but he has made a mistake in suggesting that the time limit is more in Alberta. At the examination held in Great Britain, first class, November, 1913, the time allowed for each paper of 6 questions was 2 hours, averaging 20 minutes each question. If he will look up the Alberta average he will find it is less. Also, there are seven different papers set in the Alberta examination as against six in Great Britain, and to try any comparison with the stiffness of both examinations, I think he will be satisfied after reading both, that the choice lies in Great Britain for the candidate. In any case I don't think it fair to the mining student of Alberta, to grant certificates to any person who may have obtained them elsewhere without an examination, until that law becomes universal, so that an Albertan could obtain the same privilege in any other province or the old country. As it stands now, he has to pass these examinations wherever he may go, yet a stranger may succeed in having a certificate granted him in Alberta.

M. Cranston

Ventilation and Fire

Editor The Colliery Engineer:

Sir:—(*a*) How do you ventilate the rooms turned off a pair of butt entries with breakthroughs not more than 105 feet apart?

(*b*) How would you approach a mine fire, not knowing the extent of

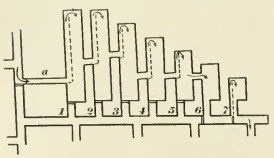


Fig. 1

the fire and assuming it to be on the intake airway? Would you approach it from both sides in a gaseous mine; and what should be done with the ventilation? J. H. F.

(*a*) It is common practice to turn the air through a breakthrough or "bleeder," *a* in the reserve pillar. This eliminates the use of a door on the haulage road. The arrows in Fig. 1 indicate the direction of the air-current. The door in the roadway at room 6 is, of course, necessary until a breakthrough is driven to room 7. A double line indicates a door and a dotted line, the brattice.

(*b*) Approach the fire on the intake airway, and under no circumstances on the return, especially in a gaseous mine.

Anthracite Dust

Editor The Colliery Engineer:

Sir:—I read with great interest the editorial on "Anthracite Dust" in the May issue and was glad to see the statements so pronounced.

During the past year several fatal accidents have occurred in the anthracite region which have caused the well-meaning, but misinformed, minority to believe in the explosibility of anthracite dust, simply because a pillar ran, or the roof caved causing a rush of air which they attributed as the cause of spreading the dust in an explosive mixture.

As a matter of fact, there are two cases like that, which I have in mind. The one where a pillar ran, raising clouds of dust; a miner nearby put his lamp in a large "pocket" of gas and he was roasted to death. Yet the dust in the air was practically stagnant all the time, after the first inrush of air, owing to the combustion of the gas.

The other case was exactly similar, save that the dust in the case was caused by the falling of the roof. If, in this case, anthracite dust had been explosive, this mine would have been wrecked, for it occurred near an old traveling way which was covered by from 4 to 6 inches of dust almost incredibly fine. G. W.

Miner's Inch

Editor The Colliery Engineer:

Sir:—What is meant by "The Miner's Inch" and what is its value?

J. T. Robertson

Merriman says that the miner's inch may be roughly defined as the quantity of water which will flow from a vertical standard orifice, 1 inch square, when the head on the center of the orifice is $6\frac{1}{2}$ inches.

In California and Montana, however, it is established by law that 40 miner's inches are equivalent to 1 cubic foot per second. In some other states there is no legal definition or regulation, the quantity being defined by common agreement.

Haulage Problem

Editor The Colliery Engineer:

Sir:—In the May issue, Mr. Beaver asks for a diagram showing method of gathering with motors, using Nos. 1 and 2 rooms on the butt entry for partings. The writer believes that an explanation will answer the purpose.

Given a butt entry with twenty working places which will provide plenty of work for one gathering motor under ordinary circumstances. No. 1 room will be used as a storage for empties, and No. 2 room for loads, or *vice versa*.

The ordinary single side track as used with mule gathering requires too close a schedule on the part of both the haulage and gathering locomotives. A gathering motor will pick up its empties and head them into the working places. Let it then bring out a trip of loads and leave them on the side track. Suppose that meantime the haulage motor has placed more empties. The gathering motor will proceed as before, but when it comes out to the side track it will be sandwiched between its first and its present trip. With mule haulage this is not the case, as the mule can turn out of the way of the loads he is pulling, while a flying switch with a motor is dangerous at best.

The writer's argument is simply that with motor gathering it is essential to have two side tracks instead of one, and that as Nos. 1 and 2 rooms can be used for the purpose as well as partings slabbed or turned through the pillar, it is better to use them. Even though Nos. 1 and 2 rooms are working at the time, it is still possible to use this method, though usually Nos. 1 and 2 rooms will be worked out before the work on the entry will require the full services of a gathering motor, before which time the side track on the entry will not be necessary.

In practise it is found that with the method outlined, provided there are sufficient mine cars, the haulage and gathering locomotives may proceed about their work without one waiting on the other side for loads or empties.

Subscriber

Pennsylvania Anthracite Section of the A.I.M.E.

In accordance with the new policy of the American Institute of Mining Engineers of establishing local sections in various mining fields whereby the advantages of this great technical society may be made more beneficial to a greater number of individual members, a Pennsylvania Anthracite Section has been organized which will hold meetings in various parts of the anthracite region for the reading and discussion of technical papers relating to coal mining. These meetings will be held three or four times each year.

The first meeting, which was a very successful one, occurred on Saturday evening, May 9, in the auditorium of the Lehigh & Wilkes-Barre Coal Co.'s office building, at Wilkes-Barre, Pa. By-laws for the section were adopted and the following officers and members of the executive committee elected: Chairman, R. V. Norris, E. M., Wilkes-Barre; vice-chairmen, C. F. Huber, President Lehigh & Wilkes-Barre Coal Co., Wilkes-Barre; Edwin Ludlow, Vice-president and General Manager Lehigh Coal and Navigation Co., Lansford, Pa.; W. J. Richards, President Philadelphia & Reading Coal and Iron Co., Pottsville, Pa.; A. H. Storrs, E. M., Scranton; Secretary-Treasurer, Charles Enzian, E. M., U. S. Bureau of Mines, Wilkes-Barre, Pa.

The executive committee consists of the elected officers and Messrs. Douglas Bunting, Chief Engineer Lehigh & Wilkes-Barre Coal Co.; Rufus J. Foster, Managing Editor The Colliery Engineer, Scranton; Frank A. Hill, Pottsville, General Manager Madeira-Hill Coal Co.; J. M. Humphreys, Wilkes-Barre, Mining Engineer Lehigh Valley Coal Co.; A. B. Jessup, Jeddo, Manager George B. Markle & Co.; R. A. Quin, Wilkes-Barre, General Manager Susquehanna Coal Co.

Mr. Douglas Bunting, chairman of the Committee on "Mining Under Heavy Wash," read an important paper in which he treated consecutively the various accidents in the anthracite field due to the caving of mines near the surface, accompanied by an inrush of quicksand, water, etc. In the paper he emphasized the point that these accidents were few in number, owing to the precautionary measures taken by the coal mining companies. He calculated by means of the flexure formula, the moduli of rupture for various kinds of rock found overlying the seam and drew curves showing the safety limit under varying conditions. He showed that the flexure formula, $S\frac{I}{C}=M$, is only true for stresses within the elastic limit of the material. When used to determine the size of the load that will cause rupture the formula becomes entirely empirical, and is not a rational basis.

Mr. Bunting referred to the "buried valley" in the Wyoming region, and particularly to the rock contour which has been quite accurately proven to date. In closing he stated that his paper was merely a preface and that he would welcome suggestions and corrections.

In the discussion that followed Major Irving A. Stearns, E. M., formerly general manager of the Pennsylvania Railroad coal interests, and Chairman R. V. Norris gave further information regarding the cave at Nanticoke some years ago, which was the most disastrous of any, as far as human life was concerned. Major Stearns stated that test holes were drilled in the river valley to define the rock contour, but the cave occurred on a high hill, the top of which was covered by a high culm bank, and there were croppings of rock on both sides. He explained by aid of a rough draft made on the blackboard by Mr. Norris, that the accident was due to a pot hole in an entirely unlooked for locality.

Mr. William Griffith, mining engineer and geologist, of Scranton, spoke on the subsidence at West Pittston, due to the Clear Spring colliery work-

ings, and expressed the opinion as to its cause that, owing to the workings having been flooded for a considerable time a 2-foot stratum of fireclay overlying the seam had become slacked. When the water was pumped out the slacked fireclay worked out, and the settlement was due to the superincumbent strata breaking and falling, not only in every open place in the seam, but over the pillars as well, and that the broken strata admitted the water, which practically ruined the mine. He stated further that he received recently an account of mines being operated in Europe in the Danube River valley where the workings under the river were flushed full of surface material after first working. This flushing was used for roof support until the coal was wholly extracted when the entire worked area was flushed. In this work he said they are using the flushing system first devised in the anthracite fields of Pennsylvania.

Messrs. Harry W. Montz and Harry H. Otto, of the Lehigh Valley Coal Co.'s engineering department, told of the methods employed by that company in determining the rock contour under the "buried valley" by drilling test holes in 200-foot squares, afterward filling them up with cement. The plan used is, that when rock is encountered they drill into it for a depth of 10 feet to prove it is not a boulder. Mr. Montz advanced the idea that it would be practicable to lay out the test holes in rectangular units instead of squares, the sides of the unit being parallel to the axis of the basin, and asked for comments on the subject.

Mr. Hill, when called on for remarks on the subject, referred to the work of the second Geological Survey of Pennsylvania on which he was engaged, and quoted from his report made some 30 years ago. He then expressed admiration for the skill with which the mining engineers and mine officials of the Wyoming Valley had handled a difficult and dangerous problem.

Mr. George Engle, engineer of the Lackawanna Coal Co. (Temple Iron Co. properties), described the method that company was using and some of the results obtained.

Mr. K. M. Smith, of the Alden Coal Co., briefly described the methods whereby a small basin of coal under considerable load of wash and with comparatively thin overlying rock strata was entirely worked out by means of the flushing system.

Mr. A. H. Storrs, mining engineer, Scranton, formerly connected with the D. L. & W. Coal Department, related the peculiar phenomena at the Avondale mine, below Plymouth, where the subsidence due to mining under heavy wash occurred some years ago.

In the discussion it was shown that the subject was one of great importance and that so much of value had been brought out by Mr. Bunting and those who discussed his paper that it was advisable to continue the committee for further investigation of the subject.

Mr. Norris, chairman, then announced that owing to a sudden attack of illness Mr. J. M. Humphreys, chairman of the Committee on "Mining Coal Near the Surface by Stripping Operations," was unable to be present, but as the first paper and discussion occupied the attention of the meeting until after 10 o'clock, he thought a mistake had been made in announcing two important papers for one meeting, because the one interesting paper and its discussion had occupied practically all the available time, and he would, therefore, entertain a motion to adjourn.

Before the motion was put it was decided that the next meeting of the Section should be held during the summer in the auditorium of the Philadelphia & Reading Coal and Iron Co.'s office building, Pottsville, and the fall meeting should, on the invitation of Mr. Ludlow, be held at Lansford. Dates for both meetings and the programs will be announced later by the executive committee.

The annual cost for new mules in the anthracite mines is $38,654, and the cost of feeding all mine stock is $1,073,859 per annum.

Explosion Not Caused by Acetylene

On January 27, 1914, an explosion occurred in the Wheeling Creek mine, of the Lorain Coal and Dock Co., near Bridgeport, Ohio. This explosion which resulted in the death of one man was at first supposed to have originated from an explosion of acetylene gas generated from some unexhausted carbide dumped out of an acetylene mine lamp.

Some carbide residue was found in a breakthrough about 150 feet from the center of the explosion, which had probably been emptied from a lamp. As a preliminary, pending a thorough investigation into the cause of the explosion, a temporary order was issued prohibiting the use of acetylene lamps in the mine.

The mine workers refused to work in the mine unless allowed to use the carbide, or acetylene, lamps, and through their local union demanded a thorough investigation into the cause of the accident. Such investigation being also desired by the company, and required by law, was made by Chief Mine Inspector Davies, Deputy Inspector Gaffney, Safety Commissioner of Mines Roan, and other deputy inspectors, mine officials, and experts of Ohio.

It was soon demonstrated that as the residue left by the carbide lamps is merely slacked lime it could not be considered as a cause and it was proved conclusively that even had there been fresh carbide in the breakthrough, it could not have had anything to do with the explosion as the breakthrough was dry. Carbide will not give off sufficient gas, when exposed to the air, to cause an explosive mixture or an ignitable mixture unless brought in contact with actual water. The moisture in the air is not sufficient to make enough acetylene to ignite. There can never be an accumulation of gas produced from carbide from moist air for the obvious reason that in order to produce gas, any air which has given up its moisture to produce

acetylene must move on and the acetylene goes with it. The careful investigation of the location of the carbide residue showed that as a matter of fact, this residue was shut off from the butt entry in which the explosion occurred by a substantial brattice, the residue being located within 3 feet of the adjoining butt entry, and as before stated with a brattice between it and the butt entry in which the explosion occurred.

When these facts became apparent, the order prohibiting the use of actylene was rescinded by the Chief Mine Inspector, his deputies and the Safety Commissioner. The work of the Ohio Mine Inspectors and the Safety Commissioner was supplemented by an investigation conducted by Mr. J. W. Paul of the United States Bureau of Mines. It was found that the explosion was caused by an accumulation of firedamp intensified by dust.

The Trouble in Colorado

A Concise History of the Anarchistic Conditions that Led up to Intervention by the National Government

Written for The Colliery Engineer

THE state of anarchy that has existed in the coal fields of Colorado for some months past, and the attendant bloodshed, brutality, and incendiarism are a reproach to the state.

Three large coal mining companies, the Colorado Fuel and Iron Co., the Victor-American Fuel Co., and the Rocky Mountain Fuel Co., with about thirty smaller companies, control the coal industry of the state. For some years the only organization of miners was the Western Federation, and this was most largely composed of ore miners. It was under the leadership of Haywood and others, whose records as trouble breeders and advocates of violence were, and still are, very bad.

A few years ago the United Mine Workers of America absorbed those of the coal miners who were allied with the Western Federation of Miners. For some time previous to, and even up to the time of this absorption, conservative members of the United Mine Workers opposed the combination.

The trouble commenced in the southern Colorado coal fields. The unrest began over a year ago. It is claimed that nearly 80 per cent. of the mine workers are Greeks, Italians, Slavs, and Mexicans, of these about 10 per cent. were unionized. The mine camps, owing to the topography and geological conditions, are somewhat isolated, and as is usual under such conditions, company stores were established.

Last summer the union miners, through their leaders, formulated the following demands on the mine owners:

(1) Miners to have the privilege of choosing a check-weighman.

(2) Mine workers to be permitted to trade at any store.

(3) Pay days to be bimonthly, and wages to be paid in cash.

(4) Working conditions in the mines to be improved.

(5) Recognition of the union.

(6) A 10-per-cent. advance in the wages.

(7) An 8-hour day.

The mine owners, while consenting to receive and consider demands from their own employes declined to receive delegations as representatives of the union.

In a general reply to the demands, the operators declared that the first and second demands had never been denied their employes. They had no objection to the miners' checkweighman, and they could not, if they wished, enforce a demand for trade at any store. They consented to the third demand. The fourth, they contended was governed by the new and very drastic mine law of the state, and they expressed willingness to aid in the enforcement of its provisions. They refused the fifth demand. The sixth demand they claimed had been granted before the demands were made, and the seventh demand was a matter that the miners could regulate themselves.

As will be seen, the real bone of contention was demand No. 5.

On September 23, a general strike was ordered. As a majority of the mine workers were non-union men and they were willing to work under the existing conditions, the operators notified them that they could work, and would be protected in doing so. As the men who remained at work were threatened by letter and otherwise they asked for protection. Therefore special guards, heavily armed, were employed to protect them, and the mine property. To take the places of the strikers and give the mines a full complement of men, outside help was hired.

In a short time minor acts of violence commenced. The strikers and their families formed tent colonies, and the men, heavily armed, under the leadership of men who preached a doctrine of violence, attacked some of the working plants. This resulted in collisions between the strikers and the mine guards with disastrous results. Naturally, the opposition of the mine guards and their use of guns in defence of the men and property under their care, still further inflamed the passions of the strikers, and it is possible that some of the guards, not being under strict military discipline committed acts that their employers would not countenance.

After numerous calls on the Governor for the state militia to put down the disorder, and afford protection to life and property, the National Guard of Colorado was sent into the region in October, after the strikers had fired into the miners' houses at Hastings and Berwind. The militia remained in the field until the 16th of April with the exception of 40 men under command of Major Hamrock. On April 20, there was a battle at Ludlow, Colo., between this small body of militia and the strikers. The officers of the militia claim that strikers

fired on a detachment of soldiers sent out to investigate the origin and cause of some firing that had occurred. The militiamen fled and took a position on a nearby hill, and then commenced a battle between the 40 militia men and 200 armed strikers. The firing in all lasted 14 hours, a machine-gun fire being directed on the strikers' colony at Ludlow. The colony was entirely destroyed by fire. Under the tents pits had been dug and these covered with boards afforded protection from shots to the women and children. The fire among the tents spread so rapidly that some of the non-combatants were unable to escape, and the bodies of two women and eleven children were found in the pits. Captain Carson and Lieut. Linderfelt of the militia under fire rescued some forty women and children, and could have saved the eleven that perished, had they known they were in the pit. Among the combatants, the losses were one soldier killed, one fatally wounded, and one less seriously wounded. Among the strikers 14, including Louis Tikas, a Greek leader, were killed and about 20 were wounded.

On April 22, scouts having reported that a band of strikers was marching on the Delagua plant, 15 guards went out to meet them, and a fight occurred about a quarter mile from the camp. The guards retreated to the mine buildings, and held the strikers in check until militiamen sent from Ludlow, in steel cars, reinforced them, when the attacking party was repulsed. Two mine guards and two non-combatants were killed.

Shortly after the affair at Delagua a body of strikers made an attack on the Empire Coal Mining Co.'s plant at Aguilar. Thirty-five persons, including five women and children were compelled to seek safety in the mine. The strikers set fire to the tipple, and it is stated that they dynamited the mouth of the mine in an attempt to seal the exit of those who sought refuge in it. Later these imprisoned people were all rescued.

On April 22, the entire National Guard of Colorado was called out and ordered to mobilize in Denver, and on the 24th they were in service at the points of trouble.

On April 23 the following plants were reported as burned by strikers: The Primrose mine of the C. F. & I. Co., Mine No. 4 of the Southern Colorado Fuel Co., the Empire mine of the Empire Coal Co., the Southwestern mine of the Southwestern Fuel Co., the Green Cañon mine of the National Fuel Co., the Rugby mine of the C. F. & I. Co., and the Forbes mine of the Rocky Mt. Fuel Co. The Royal and Brodhead mines, previously burned, made a total of nine collieries in the Trinidad field whose surface plants were destroyed by strikers.

In the northern coal field comparative order was maintained until the militia stationed there was moved south to assist in suppressing the trouble in the southern field.

They had hardly left, before violence commenced. On April 26 the Victor-American Fuel Co.'s Chandler mine, in Fremont County, was captured by a force of strikers, but they were driven off the next day by two companies of the militia. On the same date the McNally plant of the C. F. & I. Co., near Walsenberg, was burned, and during the night seven guards were shot at the Walsen mine nearby. On the next day the Rocky Mountain Fuel Co.'s Hecla mine, about 24 miles north of Denver, was attacked by strikers, but they were held in check by the mine guards. The same night the Gorman mine, near Marshall, and the Vulcan mine, near Lafayette, were attacked, but in both instances the attacking parties were driven off.

On April 28, it being evident that the Colorado authorities, civil and military, were not capable of putting down what had assumed the proportions of a civil war, President Wilson ordered United States troops to the scenes of disorder. These troops are at this writing on the ground, and the militia has been withdrawn. The guards at the mines have, under direction of the mine owners, obeyed the orders of the army officers in command and have turned over all their arms to the soldiers, and measures are being taken to disarm the strikers. The presence of the regulars has restored peace, but it will be a long time before the damage done the mines can be repaired and normal conditions restored.

It will probably never be known how many persons were killed in the various engagements, but a conservative estimate places the number at nearly or quite 100.

From all available information it is evident that the strike and consequent disorder was due to the leadership of vicious men who inflamed the minds of a comparatively large body of illiterate non-English speaking men, who were easily incited to acts of violence. Some of these leaders were undoubtedly disciples of Haywood and other anarchistic former leaders of the Colorado members of the Western Federation of Miners. Later, when officials of the United Mine Workers took a hand, they were either unwilling to, or powerless to control the radical element.

It is possible, and in fact probable that some of the mine guards, by injudicious actions helped to prolong and intensify the disorder, as they were not under strict discipline, and they were in positions where there was great temptation for angry or designing men to do things that were better left undone.

In addition, the Colorado National Guard, did not cover itself with credit or glory. It seemed to lack the discipline one would expect from a body of uniformed soldiers. This lack of discipline, however, must not be blamed on the rank and file. It belongs to the state officials and probably in a measure to some of the officers of the guard.

As is frequently the case in times of labor troubles, sensational newspapers and designing politicians used the occasion to further their own interests, and, in doing so, they intensified the trouble by leading the more violent illiterate foreign speaking strikers to think they were entirely within their rights when they adopted incendiary and violent policies.

Other newspapers and public officials, ignorant of actual conditions in the region, and unfamiliar with mining conditions, contributed in a measure to intensifying the trouble by ill advised articles or speeches.

At this writing the mine guards have all turned over their arms to the regular army officials, but difficulty is being encountered in disarming the strikers. The United Mine Workers' officials on the ground are doing what they can to effect complete disarmament, but they seem to be unable to control many of the strikers. As a last resort these officials have notified the strikers who have not already given up their arms, to do so at once, otherwise they will be expelled from the organization and will be denied financial help.

Illinois Mining Institute

The Illinois Mining Institute opened its session in the assembly room of the City Hall at Peoria, Ill., on the afternoon of May 14.

The first day's meeting was chiefly a business one. One discussion, however, arose over the question of the number of accidents in machine-mined coal mines being greater than in those where the coal was mined by hand. Mr. Martin Bolt, the secretary of the Institute, said that after careful investigation and by comparison of mines working under the same conditions, the accidents per ton of coal mined in machine mines exceeded the other by a wide margin. Finally Mr. James Taylor, formerly a state mine inspector, moved that a committee be appointed to find just what the reason was for the larger number of accidents in machine mines, and to recommend a remedy for the fault. The motion was passed and the committee will be named in the near future by the chairman of the Institute, Mr. Thomas Moses.

A banquet was held in the evening at the Jefferson Hotel. The speakers were James McQuade, and P. G. Rennick, of Peoria, and David Ross, of Springfield.

On Friday, May 15, excellent papers were read both in the forenoon and in the afternoon.

Mr. Stewart A. Shive, of the Jeffrey Mfg. Co., read a paper on "Storage-Battery Locomotives." He treated it in a theoretical way as compared to the practical, taking for an example the installation of the Grant Coal Co. at Sanford, Ind. He emphasized four points about storage-battery locomotives which are well to remember.

1. The design of the storage-battery locomotive is very important. It is essential to incorporate the elements of mechanical design the same as is found in trolley locomotives.

2. It must be expected to treat the storage-battery locomotive with greater care than a trolley locomotive. Intelligent attention must be given the batteries.

3. The duty required of a storage-battery locomotive must be reasonable. The speed will not exceed 4½ miles per hour. The maximum tractive effort lies between 1,000 and 1,600 pounds. The latter figure, however, represents as large a battery as may be reasonably used on this type of locomotive. It is limited to light grades and a trip that is not too heavy or having too long a haul. A practical level and short haul is therefore ideal.

4. The operation of a storage-battery locomotive will prove more economical than a cable-reel trolley locomotive.

Mr. J. W. Starks, state mine inspector, read an interesting paper on "Safety First as Applied." He said there was one thing necessary; that is, that both companies and workmen obey the law, then safety first will materialize. He gave statistics of the fatal accidents in Illinois and showed that at the same rate it will cost 500,000 lives to recover all the coal deposited underground in the state, estimated at 200 billion tons. He divided the safety movement into three classes:

The state, by requiring strict examinations for men engaged in important work at the mines and the state inspection service.

The operators, by employing competent officials; by providing adequate timber, supplies, etc., and by gaining the confidence of the men and making them understand that it is their safety they have at heart. They are providing careful inspection of all the equipment, the roadways are kept clean, tracks in better condition, trolley wires guarded, etc.

Lastly, the miner helps by following his instructions without a question and using good judgment.

G. M. Bolus, of the Ohio Brass Co., read a paper on "Rail Bonding and Overhead Construction," illustrating with figures and curves the results of his experiments with various types of bonding materials and wire hangers.

Mine Inspector Thomas H. Devlin in a paper on "Longwall Mining in Illinois," said that the reason the room-and-pillar system was adopted in a great many places was because of the lack of good competent longwall men.

John P. Reese, general superintendent of the Superior Coal Co., of Gillespie, Ill., was unable to be present to read his paper on "First Aid in Mine Accidents" so it was read by John H. Ross of the same company. Mr. Ross emphasized the need of organization and said that when a man left his work to attend an injured man and perhaps to take him home, he should be paid for that work. He said that, in one case a local union of the United Mine Workers of America cooperated by also paying such men in those cases. He then made a motion to have a committee appointed to take up the first-aid movement with the officials of the U. M. W. of A. in the state and get them interested as an organization. The motion was unanimously passed.

The sessions of the day were then closed by an automobile ride through the city of Peoria and its beautiful suburban parks.

On Saturday morning the Institute convened for a business session

and named Springfield as its place of meeting in November.

Resolutions of condolence for the family of the late Stephen Woschlag were presented and passed. Mr. David Ross addressed the institute on the "Workmen's Compensation Law," and emphasized the fact that it is not a new idea, because the Federal government passed such a law 32 years ago covering the life-saving service. The meeting was in the hands of John Dunlop, ex-mine inspector, who was the chairman of the committee on arrangements, and it was due to his efforts that the meeting was a pronounced success.

Notes on Mines and Mining

D. J. Mackay & Co., of Evansville, have purchased at receiver's sale the Hartwell mine property, in Pike County, Ind., including three shafts, 4 miles of railroad, and 2,438 acres of coal land. The mines are electrically equipped and ready for a renewal of operations at any time. The new owners paid $198,750 for the property and will spend $10,000 in improvements. Three hundred miners will be given employment.

KENTUCKY

The Buffalo Creek Coal Co., which was recently organized at Ashland, Ky., by local people, will shortly begin the opening of a mine on the Sandy Valley and Elkhorn Railway, in the Elkhorn field of eastern Kentucky.

PENNSYLVANIA

Lehigh Coke Co.—The H. Koppers Co. has received the contract for the erection of four batteries of Koppers by-product ovens, at South Bethlehem, Pa., that will be capable of carbonizing 6,000 gross tons of coal daily, operating on 20-hour coking time. Two of the batteries are being erected to the east of the present Dider-March, Nos. 3 and 4, batteries and the other two are to be erected in place of the present batteries. The ovens will also be capable of carbonizing a proportionate amount of coal on 24 hours coking time. The ovens of the present by-product plant will be equipped for gas separation. There will be furnished also a coal storage bin, quenching, screening, and loading equipments and all necessary appliances for the proper operation of the ovens. The two new batteries erected to the east of the present batteries, Nos. 3 and 4, are to be completed in 300 working days from March 10, and the removal of the present ovens and the building of the two new batteries will be completed in 360 working days from the time when the batteries are turned over to the Koppers company empty of coke and coal. The ovens are to have a capacity of not less than 13½ net tons of coal or approximately 540 cubic feet of oven capacity.

The Somerset and Cambria Coal Co. has been shipping from two mines, and work was recently put under way on a third opening. The development work will be continued under the new ownership, and it is also planned to equip all the mines with electrical machinery. An output of 1,000 tons a day is expected from the three openings within 90 days, all of which will be handled at one tipple. It is proposed to install screens at the tipple during the coming year, so as to be in a position to ship lump coal as well as run of mine. Two of the openings are in the Miller vein and one in the C′.

At a meeting of the board of directors of the Temple Iron Co., held on May 1, the announcement was made that S. Brinckerhoff Thorne, of Thorne, Neale & Co., the highest of six bidders, had purchased the stock in eight coal companies that has been owned for some years past by the Temple Iron Co. Mr. Thorne, who is the senior member of the firm named, was for several years, general manager of the Temple Iron Co. and is therefore very well acquainted with the properties that he has now secured possession of. At the same meeting the directors of the Temple Iron Co. elected E. T. Stotesbury, head of the firm of Drexel & Co., and a member of the firm of J. P. Morgan & Co., as president pro tem to succeed the late George F. Baer, and Robert W. de Forest to take Mr. Baer's place as a director. Mr. de Forest is also vice-president and general counsel of the Central Railroad Co., of New Jersey.

TENNESSEE

Messrs. Seabrook & Howard, wholesale coal dealers, and other parties of Atlanta, have purchased the property of the old Rock Spring Coal Co., located on the Southern Railroad at Turley, Tenn., and have organized the Turley Coal Co., to take over and operate the property. The plant will be thoroughly overhauled, machinery rearranged and the incline reconstructed upon the plans of A. H. Wood, consulting mining engineer of Petros, Tenn., with J. H. Rogers, formerly of Coalmont, Tenn., as superintendent of the mine in charge of the operation. A large amount of money was spent on this property two or three years ago, but the equipment for handling the coal was a failure, although there is a valuable seam of coal on the property.

The Mining Department of the University of Tennessee, at Knoxville, offered a two weeks' course in practical mining subjects to candidates who were qualifying for the State Mine Foremen's Examinations, and to others who cared to take the work. The course began Monday, May 18, and continued to Saturday, May 30. It was under the direction of Doctor Jarvis, who was assisted by George E. Sylvester, chief mine inspector of Tennessee, and his assistants, besides other practical mining men of the state. The courses were grouped according to subjects and days, so that those who were unable to remain for the entire course could select those topics of most importance to them, and arrange to be present on those days. The subjects and the amount of time allotted to them follow: Mine gas, 1 day; mine ventilation, 2 days; method of mining, 3 days; the use of electricity in mines, 1 day; explosives used in mines, 1 day; mine drainage and haulage, 2 days; inspection, discipline, and sanitation in and around mines, mining law, 1 day; mine accident, first-aid and rescue work, 1 day. The course was free.

Answers to Examination Questions

Questions Asked at an Examination for Mine Foreman, Held at Sheridan, Wyoming, 1914

(Continued from the May Issue)

Ques. 20.— 15,000 cubic feet of air per minute pass through a certain airway when the water gauge reads 2 inches. What will the water gauge read when 30,000 cubic feet of air per minute are passing through the same airway; other things remaining equal?

Ans.—The water gauge is increased in the ratio of the squares of the quantities of air in circulation. That is, if the quantity of air is doubled $(30{,}000 \div 15{,}000 = 2)$, the water gauge will be increased in the ratio of the square of 2, or 4, $(2^2 = 4)$, and will be $2 \times 4 = 8$ inches.

Ques. 21.—In Wyoming there are in use blow fans, exhaust fans, and furnaces. Name the conditions under which one of these might have advantages over the other. Also give the disadvantages of each and state your preference ordinarily.

Ans.—Furnaces should not be used for the permanent ventilation equipment of a mine, whether gaseous or non-gaseous, because of the higher cost of operation compared with that of a fan producing the same volume of air, and because it is not generally possible to increase the volume of the ventilating current produced by them in case of necessity. In gaseous mines, including in the definition those containing explosive dusts, it is apparent that any kind of fire underground, even if the furnace is provided with a dumb drift, should not be tolerated. In development work and until the installation of a fan a furnace is permissible, furnishing a cheaply built and operated means of supplying enough air for preliminary operations.

Aside from the lower cost of producing a given volume of air, fan ventilation is to be preferred to furnace ventilation because the fan is on the surface where it is less liable to injury or accident, and where it is more easily repaired in event of damage; because the quantity of air in circulation can be decreased or increased (within certain limits) at will or as underground conditions demand; and because the direction of the air-current in the mine can be changed when needed by altering the position of the shutters at the fan.

While, theoretically, a blow fan may be more efficient than an exhaust fan, as it operates upon heavier air, yet, practically, the one is as effective and as economical in operation as the other. In gaseous mines, owing to the concentration of the gas in the return, it is desirable to have the intake airway used as the main haulage road. This necessitates the use of an exhaust fan unless doors, which are in every way objectionable, are placed across the haulageway. On the other hand the humidity of the return air is always high, so that in dry and dusty mines where artificial means of laying the dust are not employed, it may be advantageous to make the return airway the haulage road. In this case the use of blow fans is recommended. Further, if the intake air is heated and moistened with exhaust or live steam as a means of humidification, a blow fan is commonly employed. This is because it is much easier to heat and moisten the air on the inby side of a blow fan than at the mouth of the intake entry, a procedure necessary when an exhaust fan is used. Further, the introduction of steam into the mouth of the intake, fogs the air and interferes with the haulage.

It is now generally recognized that the preheating and premoistening of the air at the drift mouth does not furnish a sufficient quantity of moisture to wet the dust below the explosive point. Further, it is recognized that in the presence of such explosive dusts as much as 1 per cent. of methane in the return air is a source of danger. For these reasons, exhaust fans are preferred to blow fans in gaseous and dusty mines. When they are used, the haulage road, which is commonly very dusty, is the intake, doors are avoided, and, while the air may be humidified to a certain extent at the drift mouth, the chief reliance in wetting the dust is placed upon the use of hose with the further use of sprays at established intervals.

Ques. 22.—If 35,000 cubic feet of air per minute are passing through an airway 7.5 ft. × 5.5 ft. in dimensions, what is the velocity of the air in feet per second?

Ans.—The area of the heading is $7.5 \times 5.5 = 41.25$ square feet. The velocity of the air is equal to the quantity divided by the area of the heading, or $35{,}000 \div 41.25 = 848.48$ feet per minute. The velocity per second is $848.48 \div 60 = 14.14$ feet.

Ques. 23.—(*a*) What dangers arise from solid shooting? (*b*) Explain the cause or causes of blown-out shots. (*c*) What special precautions are necessary in dry and dusty mines?

Ans.—(*a*) In shooting off the solid there is but one free face and

unless the miner is highly skilled, the shot holes are very apt to be poorly placed, resulting in a blown-out shot even if not overcharged with powder or improperly tamped. Further, in solid shooting, dependent shots are very commonly employed and if one of them fails to explode at the same time as the others, the miner returning to the face in ignorance of this may be killed or badly injured by the delayed explosion of such charges. In solid shooting, excessive amounts of powder are very apt to be used. The explosion of such charges weakens the roof and increases the accidents due to falls; grinds the coal to dust, furnishing more material for a dust explosion; and the very large volume of flame and hot gases thrown into the mine air is apt to throw into suspension and ignite any fine dust in the working place.

(*b*) Blown-out shots commonly arise from the drill hole being poorly placed; that is, the hole is so drilled that the powder is not able to overcome the resistance to rupture of the coal with the result that the tamping is blown out. Or they may be caused, even in well-placed holes, by an insufficiency of tamping, which offers less resistance to being blown out than the coal does to being blown down. Very quick acting powders may blow out the tamping in preference to blowing down the coal, and heavy charges of powder contained in holes of large diameter may do the same thing.

(*c*) In dry and dusty mines, the coal should always be undercut to a depth not less than that of the deepest drill hole used and preferably for 6 inches more; the shot holes should be so placed that the width at the toes is equal to or less than that at the heel, and this width should be, as a very general rule, less than the depth of the undercut or length of free face against which the shot is working; permissible short-flame powder should be used exclusively; not more than 1½ pounds of this powder should be used in any hole; nor should more than three holes so charged and placed be used in any one room; dependent shots should not be used, but each hole should be placed, charged and fired, separately, except that when electric shot firing from a point without the mine is followed, two shots may be fired together provided neither one if fired singly would result in a blown-out shot and provided further that the holes are not pointed toward one another; drill holes should be thoroughly cleaned of dust before being charged, and all cuttings, bug dust, and other fine coal should be cleaned up from the face before blasting. It is advisable that the face and the working place for 60 to 80 feet back therefrom be thoroughly washed down with water or be treated with powdered shale dust before firing. It is further advisable that all holes be inspected for their proper placing and be charged and tamped with clay (not coal dust) and be fired by experienced shot firers after all other employes have left the mine.

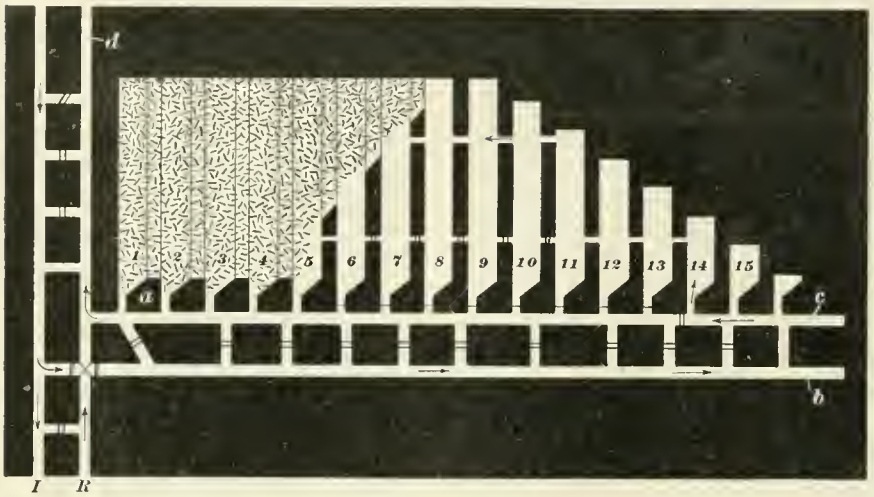


Fig 1.

Ques. 25.—Describe and illustrate by a sketch some method of working a coal field with which you are familiar.

Ans.—The accompanying Fig. 1 shows part of the main entry and one of the cross, or butt, entries and the rooms driven therefrom in what is known as the double-entry room-and-pillar system of mining. The property is assumed to be opened by a pair of parallel main entries one of which, *I*, is the intake, and the other *R* the return airway. The distance between these entries varies widely, say, from 20 to 80 feet, depending upon the nature of the roof, method of drawing pillars, etc., a common thickness of pillar being 50 feet. The entries are connected by breakthroughs, or cross-cuts at intervals of from 60 to 125 feet, 75 or 100 feet being common distances. The more gaseous the mine the closer the spacing of the breakthroughs. Each breakthrough is closed with a brattice or stopping as soon as the next breakthrough beyond (or inby) is driven, in order to keep the air-current up to the face of the main heading. The fan, in the case in question, would be placed somewhere beyond the upper limits of the sketch and at the mouth of either entry. It is apparent, from the pointing of the arrows which indicate the direction of the air-currents, that the fan is a force, or blow, fan and is placed over or at the mouth of the intake entry *I*. Haulage is done on the return and the grades are against the loaded trip. The direction of the dip of the seam is indicated by the direction in which the rooms are driven, which is always to the rise or up grade.

The main body of the coal is opened by pairs of butt, or cross, entries driven at such an angle from the main entries as to secure favor-

able grades for hauling. In the sketch, the main entries are driven directly down the dip, and the butt entries are, of course, either at right angles to the main entries, in which case they will be level, or are inclined slightly up hill so as to give some grade in favor of the loaded cars. The distance between the parallel cross-entries is commonly the same or a little less than that between the main entries, and they are connected by breakthroughs in the same way. The butt entries are driven from the main entries at intervals of from 350 to 500 feet, depending upon the length of the rooms.

The butt entries are ventilated by a separate split of air taken directly from the main intake as shown by the arrows. The air crosses over the main return by means of an overcast indicated by an × placed in the return at the mouth of the back entry; passes out the back entry, through the last breakthrough to the room entry and outby along it to the return.

Rooms may be turned from one or both of the butt entries. If the seam is flat or very nearly so the latter practice is common, but where the seam has a marked dip they are driven but from one entry, which is commonly called the room entry, and up the pitch so as to secure favorable grades for hauling. The distance between the centers of the rooms depends upon the width of the room and the thickness of the pillar between adjacent rooms, and these depend upon the thickness and character of the coal seam, the nature of the roof immediately over the seam, the depth of the seam below the surface, the method employed to draw pillars, whether machines are used for undercutting or not, on the presence or absence of gas, etc. A not infrequent width of room and pillar is 20 feet each, making the distance between centers of rooms 40 feet.

In the sketch, the rooms up to the ninth, inclusive, have been driven to the limit, leaving a pillar between their faces and the back entry of the next pair of butt entries. The rooms from the tenth on are still advancing. The dotted ground covering all the first four rooms and parts of the fifth, sixth and seventh show that the pillars are being drawn and the roof allowed to fall in them. In order to throw the air to the face while pillar drawing is in progress a curtain or door is hung across the room entry (shown by the double line between rooms 14 and 13) and other curtains are hung across the mouths of the rooms, as shown by single lines in the rooms from 6 to 13, both inclusive.

As soon as the entry is driven to its limit and the room pillars drawn, the pillar between the room and back entry is drawn beginning at the inner end and continuing back toward the main entry, leaving a continuous pillar along the right-hand side of the main entry. The thickness of this pillar is made such that any squeeze or crushing brought about by drawing the pillars on the butt entries will not ride over or be carried over into the main haulage road and airways; a common thickness is 200 feet.

Ques. 26.—When is a regulator required in a mine?

Ans.—In the sketch accompanying the answer to the preceding question it may be assumed that there are, say, three pairs of parallel butt entries driven from the main entries. These will be of different lengths and possibly of different areas and each will, thence, offer a different resistance to the passage of the air-current. It may be assumed that the quantity of air circulating in each entry will be inversely proportional to the resistance, that is, the greater the resistance, the less the air passing through any given entry.

If now it is desired to increase the quantity of air passing through the entry naturally receiving the least air, an obstruction is placed in the entry receiving the most air in order to reduce the volume circulating therein. This obstruction commonly consists of a brattice built across the entry naturally taking the most air, in which brattice is an opening the size of which may be regulated by means of a sliding shutter. As all the air in the entry must pass through this opening, the width of the opening determines the resistance to its passage and consequently to the volume of air in circulation.

Ques. 27.—Find the cost of constructing a roadway 3,000 feet long, laid with 20-pound steel rails costing $41.50 per ton; ties cost 25 cents each; spikes cost $6.50 per 100 pounds, 10 spikes weighing 1 pound; splices cost 26 cents a pair; ties are spaced 2 feet apart, center to center; rails are 20 feet long. In addition, a drain costing 56 cents per linear foot must be constructed.

Ans.—The weight of rail required to lay a mile of single track is found by multiplying the weight of the rail in pounds per yard by $\frac{11}{7}$. As the road in question is $\frac{3,000}{5,280}$ of a mile long, the result thus obtained must be multiplied by the foregoing fraction to find the number of tons required to lay 3,000 feet of track. From this,

$$\text{Weight of rail} = 20 \times \frac{11}{7} \times \frac{3,000}{5,280}$$
$$= 17.86 \text{ tons}$$

Since the ties are spaced 2 feet center to center the number required is $(3,000 \div 2) + 1 = 1,501$ ties.

The number of splice bars required, there being two to each joint for two lines of rails, will be $2\ (3,000 \div 20) + 2 = 302 = 151$ pairs.

At 4 spikes to the tie there will be required $4 \times 1,501 = 6,004$ spikes, which will weigh $6,004 \div 10 = 600.4$ pounds.

The cost of materials will therefore be

Rails, 17.86 tons, at $41.50 per ton	$741.19
Ties, 1,501 at .25 each	375.25
Splice bars, 151 pairs at $.26 per pair	39.26
Spikes, 600.4 pounds at $.065 per pound	39.03
Cost of material	$1,194.73

Although the rate of wages is not given nor are the underground conditions stated, it may be assumed that it will cost, say, $50 to haul and distribute the material along the roadway, and about $600 a mile to

lay track. This will bring the total cost of the roadway to

Material as above	$1,194.73
Placing material	50.00
Tracklaying, 3-5 mile	360.00
	$1,604.73
Add 10 per cent. for contingencies..	160.47
Total cost	$1,765.20
3,000 feet of drain at .56 per foot	1,680.00
Total cost track and drain	$3,445.20

In round numbers this will be $3,500.

Ques. 28.—A room is 300 feet long, 27 feet wide, and the coal is 9½ feet thick. What is the quantity of coal extracted from the room, allowing 10 per cent. for refuse, and assuming that 1 cubic yard of solid coal weighs 1 ton?

Ans.—The total volume of the material in the room in cubic yards is equal to the product of its three dimensions divided by 27, as there are 27 cubic feet in 1 cubic yard, and since 1 cubic yard weighs 1 ton, the figures representing the volume also represent the weight in tons.

Hence, $\frac{300\times27\times9.5}{27}=2{,}850$ tons (or cubic yards). Since 10 per cent. of the material mined is refuse, the net amount of coal is $2{,}850\times(1.00-.10=.90)=2{,}850\times.90=2{,}565$ tons.

Ques. 33.—What are the essentials for the economical haulage of coal?

Ans.—The grade should be in favor of the loads, yet not to such an extent as to offer great resistance to the return of the empty cars to the face. The track should be as straight as possible and the curves should be of large radius. The track should present a uniform surface, that is, should not have low joints, and the rails should be free from kinks. The road bed should be kept clean, particularly between the rails, and the ditches should be clear of rubbish. The rails should be of as great a weight as is economically possible, not less than 40 pounds per yard on the main entry if motor haulage is employed, and 60 pounds would be better. The ties should be large, of sound material, evenly spaced, and well ballasted with crushed rock in preference to mine dirt. The cars should be as large as can conveniently be taken to the face of the rooms, so that they may be loaded to capacity without too high a topping which may, in part, fall off and litter the track. The car wheels should be large and should be of the roller, or ball bearing, type and well lubricated to reduce friction. The body of the car and the doors should be tight to prevent leakage of fine coal, which suggests the advisability of using steel cars without end gates and the employment of a cradle or rotary dump at the tipple.

Ques. 34.—What is the difference between a common siphon and a pump situated near a sump and discharging the water 200 feet above itself?

Ans.—In the case as stated there are no points of resemblance between the siphon and the pump. The siphon depends for its action upon the pressure of the air, which at sea level is sufficiently great to balance the weight of a column of water about 34 feet high. That is, a siphon at sea level can theoretically raise water to a height of 34 feet, which in practice is reduced to 25 to 28 feet, depending upon the inclination and length of the pipe.

To raise water to a height of 200 feet requires a pump in which pressure of steam upon a plunger forces the water upwards. The water commonly flows or is forced into the pump by the pressure of the air in exactly the same way that it rises in a siphon. That is, the suction of a pump at sea level is theoretically the same as that of a siphon, or 34 feet, but is in practice but 25 to 28 feet. Any elevation of the water above this height is secured by the pressure of the steam against the plunger.

Catalogs Received

Morgan-Gardner Electric Co., Chicago, Ill. Continuous Coal Cutters, 32 pages.

Fairbanks, Morse & Co., Chicago, Ill. Bulletin 29, Direct-Current Type "TRG" Motors and Generators, 8 pages; Bulletin 27, Direct-Current Type "CP" Motors and Generators, 8 pages; Bulletin 210, Internal Starter Motors, 12 pages; Bulletin 202H, Alternating-Current Type "B" Constant Speed Induction Motors, 20 pages.

The McMyler Interstate Co., Cleveland, Ohio. Bulletins: Standard-Gauge Locomotive Cranes; Two Line Concrete Buckets; Stationary Hand-Power Pillar and Jib Cranes; Clam-Shell and Orange-Peel Buckets; Material Handling Tubs; Type "J" Standard-Gauge Locomotive Cranes; No. 12 Railroad Locomotive Pile Driver, and No. 11 Blowers Type Railroad Pile Driver, 92 pages.

General Electric Co., Schenectady, N. Y. Index to Descriptive Bulletins, 12 pages; Portable Test Meter for Alternating Current Circuits, 5 pages.

Wolfe Safety Lamp Co. of America, 47-49 West Street, New York, N. Y. Wolfe Naphtha Safety Lamps, 40 pages.

The Jeffrey Mfg. Co., Columbus, Ohio. Jeffrey "Arcwall" Coal Cutters, 8 pages.

The Goulds Mfg. Co., Seneca Falls, N. Y. Bulletin 118, Centrifugal Fire Pumps, 12 pages.

The Baldwin Locomotive Works, Philadelphia, Pa. Logging Locomotives, 60 pages.

The American Rolling Mill Co., Middletown, Ohio. Public Opinion on American Ingot Iron, 44 pages.

The Richardson-Phenix Co., Milwaukee, Wis. Richardson and Phenix Individual Oiling and Filtering Systems, 48 pages.

The Burt Mfg. Co., Akron, Ohio. Burt Oil Filters, Exhaust Heads, and Ventilators, booklet, 127 pages.

Highland Chemical Products Co., Connellsville, Pa. The Sulphurette—and its finish, 14 pages.

A. F. Plock, Pittsburg, Pa. Hinkel's Patent Safety Stop, 32 pages.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Chicago Gatling Drills, 24 pages; The Chicago Stoper, 24 pages; No. 5 Chicago Plug and Feather Drill, 4 pages; The Chicago Sinker, 20 pages; Duntley Electric Sensitive Drilling Stand, 4 pages; and Duntley Electric Tools, 8 pages.

Helmick Foundry–Machine Co., Fairmont, W. Va. Frogs and Switches, 22 pages.

Gray Engineering Co., 1020 Callowhill Street, Philadelphia, Pa. Gray's Automatic Combustion Control System, 20 pages.

Herman Bacharach, 14 Wood Street, Pittsburg, Pa. Hydro Volume and Pressure Recorders, 16 pages.

Chicago Bridge and Iron Works, 30 Church Street, New York, N. Y. Water Towers, 24 pages.

The William Powell Co., Cincinnati, Ohio. "Union" Composite Disc Valves, 12 pages.

Hazard Mfg. Co., Wilkes-Barre, Pa. Hazard 30-per-cent. Para and Hazard High-Grade Wire and Cables, 20 pages.

The Industrial Instrument Co., Foxboro, Mass. Foxboro Recorders, 18 pages.

Hayton Pump Co., Quincy, Ill. Hayton Self-Contained Portable Pumping Units, 6 pages.

Busch-Sultzer Bros.—Diesel Engine Co., St. Louis, Mo. The Diesel Engine, booklet, 112 pages.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Bulletin 2, Coal Mining Practice in District VIII.—Illinois is producing 62 million tons of coal per year; more than one-eighth of all the bituminous coal mined in the United States. The safety of the miners and the efficiency of the mining methods employed in the state are therefore matters of national concern.

The Department of Mining Engineering of the University of Illinois, the State Geological Survey, and the United States Bureau of Mines have cooperated during the past 3 years to study Illinois mining conditions. The information collected at 100 mines is published in district reports. In Bulletin 2, Coal Mining Practice in District VIII (Danville), by S. O. Andros are discussed causes of accidents to miners in Vermilion and Edgar counties, loss of natural resources by wasteful methods of blasting and mining, use of steel and concrete as substitutes for timber in the mines, and other phases of underground mining. The bulletin also contains a description of the methods of removing the overburden from a coal bed by steam shovel, a system of mining which has been highly developed in this district.

Copies of the bulletin may be obtained by addressing State Coal Mining Investigations, Urbana, Ill.

Rock Excavating and Blasting, by J. J. Cosgrove, is a book that will be useful to young engineers, superintendents, rock men, and miners. It comprises 179 pages of text with additional pages of index and 72 good illustrations, all bearing on the subject. The author states truly that the "schools of engineering teach designing, but not the construction of engineering work. A few strokes of the pen show how a tunnel is to be driven, but there is nothing shown on the drawing or taught in the schools that will point out how the work is to be accomplished." While it is true "that the old system of apprenticeship is dead and workers are left to shift for themselves and carve out of the hard rocks of experience their own futures," nevertheless, the use of explosives in the hands of those unaccustomed to them reverses matters usually and does the carving.

The National Anthem of the Canadian Mining Institute is on Rock Excavating and Blasting. A little of it, therefore, is quoted in the review:

"Our boss is a fine man all around,
But he married a great big fat fardown.
She bakes good bread and she bakes it well,
But she bakes it hard as the knobs of hell;
Then drill, ye terriers, drill.

"Last week a premature blast went off
And a mile in the air went big Jim Goff.
When pay day next it came around
Poor Jim a dollar short was found.
What for, says he, not knowing why.
You were docked for the time you were up in the sky;
Then drill, ye terriers, drill."

This verse carries out the point that Mrs. Newlywed can make mistakes with her "sinkers" and finally learn to make good bread; but, the man who follows the Recipe Book when using explosives will make a "riser" with one mistake. No one should attempt to use explosives without having seen the operation of loading a hole several times and learned the reason why "every little movement has a meaning all its own." Mr. Cosgrove has written a useful book that covers the ground admirably. It is published by the National Fire Proofing Co., Pittsburg, Pa. The price is $2.50.

Compressed Air.—By Theodore Simons, E. M., C. E., Professor of Mining Engineering, Montana School of Mines. 170 pages illustrated, $1.50 net. Published by McGraw-Hill Book Co. The book gives an insight into the natural laws and physical principles underlying the production, transmission and use of compressed air, and enables the reader to comprehend the operation of various appliances employed for that purpose and to judge of their merit. Numerous well selected practical problems constitute a strong feature of the book. Such problems make the reader familiar with actual quantities that are not revealed in mere formulas.

Idaho Coal Beds

While engaged in examining supposed coal lands in the Snake River Valley, C. F. Bowen, of the United States Geological Survey, and C. T. Kirk, made investigation of the coal beds of Horseshoe Bend and Jerusalem Valley, on Payette River, Idaho. The main results of that work have been published as Bulletin 531-H of the Geological Survey.

No definite statement regarding the extent or continuity of the coal beds can be made. So far as surface indications go, the coal is of sufficient thickness to justify development at only two localities. The area underlain by coal at each of these localities is probably small. The coal at the Henry mine has a pitch-black color, vitreous luster, black streak, and dense structure. Blocks of coal that had lain in the mine office for a year were still firm, a fact which shows that the coal might have storing properties.

NEW MINING MACHINERY

Four-Cylinder, Triple-Expansion Engine

A new high-speed engine for driving centrifugal pumps, built by the American Engine and Electric Co., is of the triple-expansion type with four cylinders. The accompanying photograph shows a 1,000-horsepower engine. The steam conditions for this unit were 250 pounds initial pressure and 25 inches vacuum.

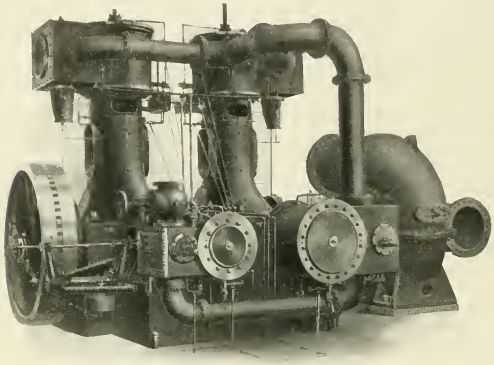


Fig. 1. Four-Cylinder Triple-Expansion Engine

Referring to Fig. 1, the high-pressure cylinder is in the foreground, the intermediate pressure cylinder to the right of this, and the low-pressure cylinders are vertical. This construction gives large ratio of expansion and therefore high economy, and eliminates an enormous low-pressure cylinder with massive reciprocating parts. With a single large, low-pressure cylinder, the speed would have to be materially reduced and this would increase the size, weight, and space required by the engine. The increase in weight would in turn, necessitate decrease in speed, so that, as is well known, if a three-cylinder triple-expansion engine is to be operated at high speeds usually desired for driving pumps, the size of the low-pressure cylinder must be reduced, with corresponding reduction in expansion ratio and economy. The difference in economy amounts to several pounds of steam per horsepower hour.

The speeds at which these engines are operated are considerably higher than those of three-cylinder engines in which economy is sacrificed to reduce the size of the low-pressure cylinder.

Vibration and pounding are eliminated, even at high speeds, so that the foundations may be light and inexpensive. When this engine is installed on a dredge boat for instance, no special stiffening of the dredge is necessary, the engine being simply supported on a cradle of I beams. For stationary plants, a simple block of concrete is all that is necessary and this is far less expensive than the foundations needed for a compound Corliss engine of equivalent power.

For example, a 1,000-horsepower, four-cylinder, triple-expansion engine of this style would require about 25 cubic yards of concrete for its foundation, while a compound Corliss engine of equal power would require 125 yards of concrete, a difference of 100 yards.

Mention may be made of the oiling system. All parts are supplied with oil from two central storage tanks, which may be seen in Fig. 1 between the two vertical low-pressure cylinders. The oil collects by gravity, is filtered and then returned to the elevated tanks by two pumps operated by the valve-gear rocker arms of the horizontal cylinders. One of these pumps with its plunger can be seen to the left, in Fig. 1.

Roller Bearing Wheels

A large coal mining company recently conducted a series of tests to determine the advantages, if any, that roller bearing mine car wheels have over solid-hub wheels.

The tests consisted of a motor hauling 20 loaded cars, holding 3.1 tons of coal in each, a distance of 3,250 feet and return, three times. The Whitney roller-bearing wheels, made by Sanford-Day Co., were used. The average time consumed for a round trip with the solid-hub wheels was 14.9 minutes, as compared with 7.5 minutes for the roller-bearing wheels. The amount of electricity used was 83.78 kilowatts for the former, and 71.81 kilowatts for the latter, or 21 kilowatt-hours for the solid-hub wheels and 8.8 kilowatt hours for the roller bearing wheels. This shows a saving of 58 per cent. of the electricity and consuming but one-

half of the time by using roller bearing wheels or approximately using two-fifths as much electricity and getting twice the speed or, roughly, increasing the efficiency of the motor four times.

The Morris Bit Machine

The Morris Bit Machine is the invention of Joseph Morris, superintendent of the O'Gara Coal Co., Harrisburg, Ill.

It is a complete machine, weighing 3,400 pounds, driven by a belt, and requiring less than a 5-horsepower motor.

It has dies for bits of any shape, and will make a new bit, or sharpen an old one, with one stroke of the hammer.

One of these machines is in operation at the No. 3 mine of the Saline County Coal Co., Harrisburg, Ill. Before the installation of the machine this mine used on an average of 70 sets of bits a day in two shifts of 8 hours each. The Morgan-Gardner chain breast, undercutting machines used hole to a depth of 7 feet, and require 43 bits for a set. It took four blacksmiths at $3 per day each, to sharpen this number of bits by

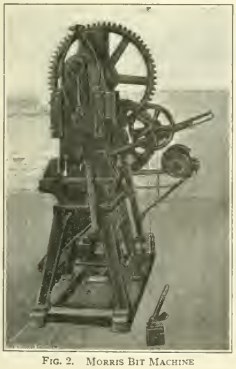


Fig. 2. Morris Bit Machine

hand. With the machine, one blacksmith and a helper have sharpened four sets in 14½ minutues. A remarkable feature is, that since the machine has been in operation, the number of bits used per day has been reduced from 70 to 44 sets and the bits are making 18 to 22 runs per set against 10 to 12 runs when sharpened by hand. This can be accounted for in part, because of the uniform shape and pitch given by the machine, as every bit is exactly like every other.

At this mine no adequate means for heating the steel is provided, the usual coal forge being used, but at a recent test, with two men heating steel, 720 new bits were made and sharpened ready for use in 1 hour. It seems that if an oil furnace, such as is used by riveters on structural steelwork was used, the steel would not burn, and any number of bits could be heated at the same time. With this arrangement, costing about $30, one man to feed the bits to the machine is all that would be required, and the oil consumption would be in the neighborhood of 30 cents per day.

Nelson Non-Return Valve

There have been so many boiler accidents caused by opening the steam valve at the wrong time, that power plant employes should be protected by using safety devices such as the non-return valve that will operate to prevent the injury to operatives.

The most important uses of the non-return valve are to utilize the pressure between the different units in a battery of boilers, and to prevent the flow of steam from traveling in a reverse direction to its normal flow.

In case a tube blows out of a boiler, the non-return valve closes automatically, owing to a reduction of pressure, and prevents the header steam from entering the boiler. It acts also as a safety stop to prevent steam being turned into a cold boiler when men are working inside, because it cannot be opened when there is pressure on the header side only.

To be successful, a non-return valve should not open until the pressure in the boiler is equal to that in the header. It should not stick and become inoperative, it should not hammer or chatter while performing

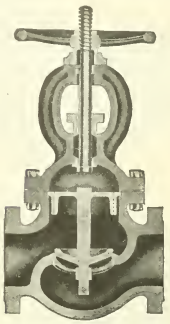


Fig. 3. Nelson Non-Return Valve

its work, and it should be so designed that wire drawing will not cause wear on the seat and the resulting leak.

In adopting these fundamental principles of safety necessary for the operation of the non-return valve, the Nelson Valve Co. have added many additional operating and construction details to the Nelson cushioned non-return valve, which are interesting from an engineering standpoint, and necessary for reliable operation.

Since a valve of this kind must necessarily operate continuously with a short stroke, the damage from wire drawing is considerable, and naturally with incorrect design, this wear will cause serious leakage. In the Nelson cushioned non-return valve, the lip, located below the seating surface, absorbs this wear, the seating surface remaining in a smooth condition.

When it is desired to use the valve as a non-return valve, the hand wheel is opened, as with the ordinary stop-valve. This allows the disk, which is a part of the piston, to operate automatically in the dashpot with slight changes of pressure. When it is desired to use it as a stop valve, the hand wheel is screwed down in the usual manner. The

hand wheel is made stationary so that the valve may be operated with small head room, which feature is often of great importance in many boiler plants.

Shaft Stairway

The structural steel stairway for shafts shown in Fig. 4, has many advantages over stairways usually adopted in escape shafts. It has

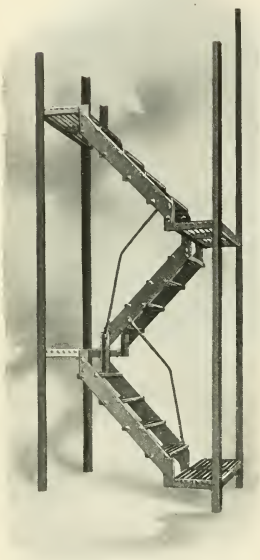


Fig. 4

strength, durability, and open construction, which permits a free circulation of air, besides, is fireproof. Each section of the stairway and each landing are separate members put together at the Litchfield Foundry and Machine Co.'s shop at Litchfield, Ill., taken apart and shipped separately to facilitate handling and installation. The construction is such that it cannot collapse, and each section with its landing is self-supporting. In some cases angle irons are placed in the corners of the shaft to carry the stairway, but in most cases the sections are bolted to the shaft lining. After the stairways and landings are assembled they are dipped in rust preventative paint so that every part is covered. Specification drawings and photographs of this stairway can be had upon application to the manufacturers.

Feedwater Difficulties

The formation of scale in boilers is simply a chemical reaction. By the analysis of water, chemists can predict the kind and proper amount of chemicals necessary to soften the water and prevent scale or corrosion. The object of feedwater heaters is to throw down the sediment in the water and in some instances impurities that are held in solution in the water. This operation, however, is not always sufficient and in spite of the feedwater heaters and purifiers, substances in solution are often deposited in the shape of scale in boilers.

There are a number of special boiler compounds, some of real value, and some that are worthless, or have little real merit. Mr. Carl F. Woods, of the firm of Arthur D. Little, Inc., chemists of Boston, recently stated before a group of street railway operators, that the employment of chemists at a cost of not over $1,000 per year would prevent the purchase of inferior compounds, which in some instances contain 97 per cent. water, 3 per cent. molasses, or possibly a mixture of soda ash, tannin, and water under a brand name, at 8 cents a pound when the principal ingredient can be obtained for 1 cent a pound.

At a recent meeting, a chemical society in Pennsylvania, the membership of which includes chemists employed in industrial and mining operations, took up the subject of Perolin, a boiler compound, manufactured by the Perolin Company of America, 1112-32 West 37th Street, Chicago, Ill. It was found that this compound did not contain anything which would be injurious to boilers under ordinary conditions. An investigation into its action where it had been used, showed that the interior of the pipes of the boilers had a thin coating similar to electroplating, and when the interiors of the tubes were examined, it was found that they had the appearance of having been polished. In the discussion it developed that this effect on the boiler pipes was the natural consequence of the use of the ingredients of Perolin, and the apparent thin coating was real, and its effect was to protect the pipes from scale and pitting.

Hinkel Automatic Safety Stop

One of the newest safety devices for mine cages is the Hinkel Automatic Safety Stop.

The basic idea of the device is the eccentric. If the cage is accidentally

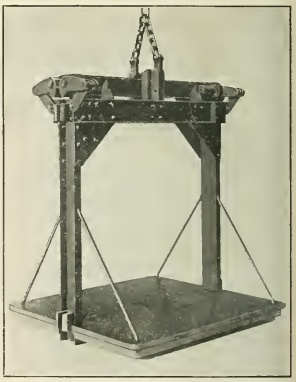


Fig. 5. Hinkel Safety Stop, Gripping Mechanism Open

released at any time, by reason of a broken rope or hoisting engine, it will be locked in place instantly and automatically. This is accomplished by means of a powerful coil, or leaf,

spring which brings the eccentric grippers in frictional contact with the guides.

It is interesting to note that wooden guides are not injured by the action of the cams in locking the cage. The device will hold the cage in its locked position while any necessary repairs to the rope or machinery are being made. This eliminates the undesirable feature of erecting a rigging by chain blocks, etc.

A Gathering Locomotive for Low Coal

Most coal men would probably consider 29 inches too small a clearance to permit the operation of a gathering locomotive, but the 5-ton Baldwin-Westinghouse locomotive shown in the illustration was designed for such conditions and operates successfully under them at the mines of the Red Jacket, Jr., Coal Co., near Williamson, W. Va. A study of the details shows what great care has been exercised in keeping the over-all height to a minimum; there is not a projection above the top of the frame anywhere and ample room has been provided to permit the operator to crouch upon his seat.

Locomotives of this kind have successfully solved the problem of gathering in low rooms. Mule gathering cannot be employed when the clearance is much less than 48 inches, so that for lower rooms the cars must be hauled out either by a locomotive or by the men. The latter method is naturally poor practice, so that gathering locomotives

Fig. 6. Low-Coal Gathering Locomotive

are in extensive use, but heretofore 36 inches has been considered about the minimum height for locomotives. A few lower ones have been built, but the one shown in Fig. 6 is exceptionally low and offers the advantage of mechanical haulage for rooms where it has hitherto been impractical.

When this locomotive is to leave the cross-entry track to enter the room, a hook on one end of the cable (which can be seen hanging over the front bumper) is hung over the trolley wire and a switch is closed which connects the other end of the cable with the motors. As the locomotive proceeds the reel unwinds, paying out the cable and giving the locomotive ample field of action independent of the trolley wire.

The reel is operated by a motor contained inside the reel drum

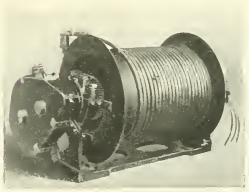


Fig. 7. Reel

shown in Fig. 7. This motor always tends to wind the cable up and its turning force acts as a brake and keeps the cable taut when the locomotive enters the room and promptly takes up all the slack when the locomotive returns.

Another interesting feature of this locomotive is its barsteel frame, each side of which is cast in one piece. This construction affords great strength, since the weight can be distributed to withstand most efficiently the shocks and stresses encountered, and at the same time makes the interior easily accessible as shown in the illustration. As a result, inspection and repairs of the inside equipment can be readily made and ample ventilation is afforded.

New Goulds Portable Mine Pump

A portable, triplex electric mine pump, size 4 in. × 6 in., designed especially for pumping mine sumps, is shown in Fig. 8. This pump, which is made by the Goulds Mfg. Co., is of the outside guided plunger type arranged so that suction or discharge can be taken from either side. It has a capacity of 65 gallons per minute and is suitable for pumping against elevations up to 500 feet. The truck upon which the pump is mounted, is of all-iron construction and is fitted with adjustable axles which can be used on any gauge truck. All working parts of the pump have guards to protect them from grit and falling rocks and to prevent injury to life and limb. No part of the pump or motor projects below the truck platform to catch in debris between the tracks.

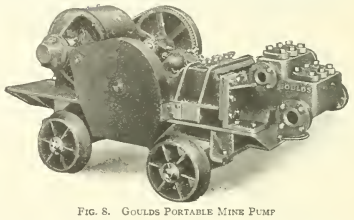


Fig. 8. Goulds Portable Mine Pump

Self-Contained Portable Pump

Occasions are frequent around mines where a portable pump that can be operated with its own power without reference to electric or air lines is of great convenience. These are especially likely to be found in dip workings in mines with comparatively shallow cover through which surface water comes in. To meet such conditions the Hayton Pump Co. has devised an outfit consisting of a centrifugal pump of their own make, either direct-connected by a flexible coupling and friction clutch, or belted to a gasoline engine, and the pump and engine with the necessary accessories are mounted on a specially

built steel truck to run on the mine track as shown in Fig. 9. These are made in different sizes, varying from discharge pipes of $1\frac{1}{4}$ inches to 5 inches diameter, and horsepower from

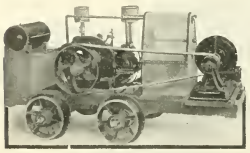


FIG. 9 GASOLINE-DRIVEN PORTABLE PUMP

2 to 18. These outfits have been in use in various fields and are stated to be giving satisfaction and to stand hard and continuous use.

TRADE NOTICES

The Buffalo Foundry and Machine Co., of Buffalo, N. Y., announce the termination of the arrangement whereby Mr. H. E. Jacoby has been representing them in New York City and vicinity. They now handle direct all inquiries covering vacuum apparatus, castings, patterns, and machine work.

A Button Conveyer.—The Fairmont Mining Machinery Co. recently installed a new conveyer for the Mineral Fuel Co., at Fleming, Ky. The conveyer is the "button type" and has a capacity of 300 tons per hour. The buttons are 12 inches in diameter. The conveyer is 360 feet long on a pitch of 35 degrees. The power is furnished by a 20-horse power General Electric motor. Five other similar installations are planned.

The Ingersoll-Rand Co. announce that Mr. R. C. Cole has joined the staff of their Pneumatic Tool Department, and has been stationed at the Chicago office.

Electric Mine Equipment.—The General Electric Co. has contracted to install electric coal mining machinery as follows:

North Jellico Coal Co., Louisville, Ky., at Woodbine and Pineville, Ky., a 500-kilowatt Curtis turbogenerator with 7-kilowatt exciter, two 200-kilowatt rotary converters, three 65-kilovolt-ampere transformers and a switchboard, and five 6-ton electric mining locomotives.

Carbon Hill Coal Co., Carbondale, Wash., a 6-ton, 500-volt combination storage-battery mining locomotive, and for charging it a 12-kilowatt motor-generator set with charging panel.

The Vinton Colliery Co., Vintondale, Pa., a 10-ton electric mining locomotive.

The Solvay Collieries Co., at Kingston, W. Va., one 5-ton, 48-inch gauge, and at Westerly, W. Va., two 5-ton, 44-inch gauge electric mining locomotives.

Steel Corporation Exhibits.—The announcement is made that the United States Steel Corporation and it subsidiary companies propose to have a comprehensive exhibit at the Panama-Pacific Exposition, in San Francisco, in 1915. It will include the manufacture of "National" pipe; the utilization of the by-products and the display of many uses in which its general products are employed. In addition to the material exhibits before mentioned, the corporation intends to exhibit in a comprehensive manner, by moving pictures, its operations throughout all departments, showing the ramifications of the processes of the corporation's operations.

The Roberts and Schaefer Co., have contracted for a Marcus patent coal tipple for the Cora Coal Co., to be installed at Andrew, Ill. This is a five-track tipple. Also a Marcus tipple for the Tecumseh Coal Mining Co., to be installed at Bicknell, Ind.

The Madeira-Hill Coal Co.,of Pottsville, Pa., recently placed a large order with the Mt. Carmel Iron Works for the new B. & K. coal jigs, to be installed at their new Lawrence colliery.

The Pennsylvania Coal Co., at Dunmore, Pa., has installed recently a number of the W. H. Nicholson's Wyoming eliminators.

The Alexander Car Replacer Co., have just made a shipment of their replacers to Bombay, India. Over 75,000 pairs are now in use all over the world.

The Aldrich Pump which has heretofore been manufactured by the Allentown Rolling Mills and the Birdsboro Steel Foundry & Machine Co. will hereafter be manufactured and sold by the Aldrich Pump Co. of Allentown, Pa. An electrically operated slush pump that is being put out by this firm is offered in competition with elevators for raising coal dirt, slush, or slime. It is guaranteed to handle economically water containing 25 to 35 per cent. of solid matter.

Eureka!!

The following is a reproduction of an advertisement in a recent number of *The Colliery Guardian*, of London:

Moxon's Practical Ideal System of Working and Ventilating a Mine.

The only system that will prevent spontaneous combustion in coal mines, and provide for larger outputs and greater safety.

My system is a natural law which cannot be patented, and cannot be given away, whether actually discovered or not, although it is the common property of all.

My price is £50,000, which is not one-half of its actual value. Money returned if not what it is represented to be.

Apply to

E. MOXON,

Crown Inn, High Green, near SHEFFIELD.

Although our British contemporary is the leading coal journal of Great Britain, and the number containing the advertisement was issued 2 months ago, we have not heard that the Crown Inn, at High Green, was overrun by British mine managers anxious to purchase the important secret offered at such a ridiculously low figure as approximately a quarter million dollars. Evidently, the British "coal barons" are an extremely unprogressive set of men. We hope that no American operator will take advantage of this evidence of unprogressiveness, and meanly purchase the secret, and thus deprive their colleagues on the other side of a discovery that will mean so much to them.

The Colliery Engineer

ol. XXXIV—No. 12 JULY, 1914 Scranton, Pa.

habetical List of Advertisers—Page 60

Classified List of Advertisers—Pages 62, 64, 66, and 68

LIBRARY
JUL 8 1914
UNIVERSITY OF TORONTO

Kingston Coal Co. Playgrounds

HOISTING ROPES

HAULAGE ROPES

HAZARD WIRE ROPE

Trade Mark

Rubber Covered Wire

Mining Machine and Locomotive Cable

Bare and Weatherproof Wire

HAZARD MFG. CO.

WILKES-BARRE, PA.

NEW YORK 533 Canal St.

PITTSBURGH 1st Nat'l Bank Bldg.

CHICAGO 552 Adams St.

ROEBLING WIRE ROPE

Used satisfactorily for more than seventy years

MADE BY

John A. Roebling's Sons Company

TRENTON, N. J.

SHIPMENTS FROM STOCK IN ROEBLING WAREHOUSES AT

New York Philadelphia Pittsburgh

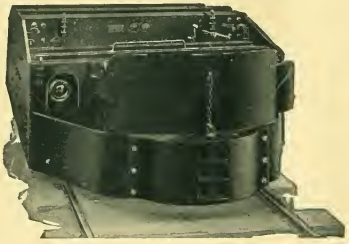
Chicago Savannah Cleveland

(Office Atlanta)

San Francisco Los Angeles

Seattle Portland, Ore.

The Low-Cost Gathering Engine



Electric Storage Battery Locomotive

Designed and built by a practical coal mining man and construction engineer—a man who owns and operates mines and uses Electric Storage Battery Locomotives **because they save labor and costs.**

Built as low as 30 inches. Weighs 2½ tons up. No trolley; no bonding rails. Simple; anyone can operate them —from either end.

Write for Low-Cost Proof

C. K. Davis Manufacturing Co.

Detroit Michigan

Briquetting 40 Tons Per Hour

involves problems that are not encountered in the making of briquetting machinery or the operation of plants of eight or ten ton capacity per hour.
Look at this combination—

Large Output
Small Briquets
Low Percentage Binder

No other equipment has ever been perfected to manufacture merchantable briquets weighing from one ounce to one pound each, at the rate of forty tons per hour with low percentage of binder. This means lower cost. Lower cost, greater capacity, and better briquets are what our plants will accomplish. Let us refer you to our clients who are actually making a commercial success of coal briquetting.

MALCOLMSON

Briquet Engineering Company

Consulting and Contracting Engineers

Old Colony Building **Chicago, Ill.**

Designers and Builders of Complete Briquetting Plants.
Sole Agents for Rutledge, Komarek, and Schorr Presses.

COPYRIGHT, 1914, BY INTERNATIONAL TEXTBOOK COMPANY
ALL RIGHTS RESERVED

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXIV—No. 12 JULY, 1914 Scranton, Pa.

PUBLISHED MONTHLY AT SCRANTON, PA.
ESTABLISHED 1881

INTERNATIONAL TEXTBOOK CO., PUBLISHERS

T. J. Foster, President S. P. Allen, Secretary E. H. Lawall, Treasurer
Rufus J. Foster, Vice-President and Managing Editor
Eugene B. Wilson, Editor Wm. Z. Price, E. M., Asst. Editor
Chicago Office: 1006 S. Michigan Ave.
Entered at the Post Office at Scranton, Pa., as second-class matter
Address all business communications to The Colliery Engineer, Scranton, Pa.

Subscription Rates: $2.00 per year to United States and all possessions, and Mexico; $2.50 to Canada; $3.00 to all other countries. Single copies 25 cents each.

Notice to discontinue or change of address should be sent to the Scranton office.

When notifying us of a change of address always give your former as well as your present address.

NUMBER OF COPIES PRINTED THIS ISSUE, 14,700

Table of Contents

Editorial—
What do You Want?—Cooperation in Mining Engineering—Safety First—Force vs. the Constitution—Breaking Colliery Rules—Responsibility 717
Personals 719
Western Montana Coal Fields, by Leroy A. Palmer 721
Welfare Work at Grant Town, W. Va., by A. W. Herstine 724
Basic Coke 725
The New Weston Colliery, by Wm. Z. Price 726
Pumping Oil a Coal Mine 728
Longwall Mining in Ohio, by Wilbur Greeley Burroughs 729
The Mining Engineers' Association 732
The Eccles Mine Explosion 733
Movable River Tipple 736
State Interference in British Mines 738
American Coal-Dust Precautions, by George S. Rice 739
Weathering of Pittsburg Coal 744
Coal Loading Methods, by J. F. Springer 745
Handling a Mine Fire 748
Efficiency Thoughts in Coal Mining, by Erasmus Haworth 749
Cost of Mine Cars 751
Anthracite Mine Engineering, by George W. Engle 753
First-Aid Contest 760
Mining Institute Meetings 760
New Method of Rock Handling 765
A Strange Accident 765
Important and Deserved Promotions 766
Barlow Medal 767
Output of Anthracite in 1913 767
Hookworm in the Pocahontas Field 767
Letter Box—
Oil in Air Receivers—Some Reflections 768
The Automobile at Coal Mines 770
Obituary—
Dr. A. E. Barlow 770
Examinations—
Foreman and Assistant Foreman, Pottsville, Pa., May 25, 1914 771
Book Review 774
New Mining Machinery—
Coal Preparation on the Marcus Screen, 775—New Wing Turbine Blower, 776—Cylinder Lubricants, 777—Oil-Driven Air Compressor, 778—Jeffrey Wagon Loader 779
Trade Notices 779
Catalogs Received 780
Squibs—
Explosives in Virginia, 736—Inspection in West Virginia, 738—Utah's Lofty Mountains, 744—Free Determination of Minerals, 752—Anthracite Shipments in June, 1914, 760—Arbor Day in Pennsylvania 767

What Do You Want?

IN THE past we have had many suggestions as to what was desired in The Colliery Engineer, and whenever the suggestions were practical they were adopted. We want more suggestions. We want to know what *you* want. The only way to find out is to ask you. Hence the question.

The next issue will be the first of Volume Thirty-five. We want to make the next volume better and more useful than the one now closing. What do you want? Let us know. The Colliery Engineer is published for you. It is up to you to criticise and offer suggestions. We want both. What do you want?

Cooperation in Mining Engineering

IN AN interesting article on "Anthracite Mine Engineering," by George W. Engel, E. M., Chief Engineer of the Temple Iron Co. group of collieries, which appears on another page, the author treats on the efficiency phases of mining engineering practices in the Northern Anthracite Field. The information given by Mr. Engel is based on his own experience, and it is supplemented by notes, statements, and other data contributed by the heads of the mining engineering departments of other companies.

In view of the varying results achieved by the use of different methods, and different details in methods, the author's suggestion that there should be cooperation between the heads of the engineering departments of other companies operating in the same districts, so that the greatest efficiency may be obtained, is a good one.

Naturally the basis of efficiency in mining engineering, as in all engineering, is accuracy, and when quick results are secured with accuracy the degree of efficiency is high.

Quick action and accuracy both depend in a large measure on the individual members of the engineering corps. In some instances men are extremely accurate and extremely slow; in others they are less accurate but quick in arriving at conclusions. If those who are quick can be trained in extreme accuracy, and can have a well considered detailed method of working they will rank higher in efficiency than their extremely slow colleagues.

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

Mr. Engel is not an advocate of speed at the expense of accuracy, but he does advocate the use of methods of work which secure both.

There is more or less difference in the details of the work of the engineering departments of most mining companies. In some cases the methods employed are the result of years of custom. In others they are the application of ideas of some individual who has aimed at greater efficiency. In every organization there will probably be found some detail that is of exceptional value, and which would be immediately adopted by other engineers if they knew of it. Conversely, there will be found in most organizations some details that can either be improved or entirely changed with advantage. The men who should determine these things are the heads of the engineering departments. Conditions confronting them in the mines under their charge will naturally influence the adoption or rejection of methods found desirable in the practice of their colleagues.

To enable the head of each engineering department in a district to determine what will tend to greatest efficiency in his corps, there should be, as Mr. Engel suggests, periodical conferences of an informal nature between the chief engineers. These conferences need not be of the nature of engineering society meetings at which lengthy papers are read and discussed. They should be of a more or less social nature in which each one present can interrogate his colleagues as to how they perform certain operations, and why they do things in a certain specific manner. Each in turn can criticise or commend, and can give his reasons for his opinion. In such a conference much can be learned, and many good ideas can be adopted or adapted with profit. While Mr. Engel in his paper refers especially to anthracite mines, the same idea of interchanges of ideas on the part of the mining engineers of bituminous coal companies operating in the same district will prove equally as valuable.

Safety First

A MOVEMENT which showed the proper spirit was made at the recent meeting of the Illinois Mining Institute, in Peoria, when the chairman was instructed to appoint a committee which was to confer with the district officials of the mine workers' union for cooperation in a state wide safety-first movement.

The attendance at the institute meeting was almost exclusively made up of operators of the state, and the sentiments voiced were those of the mine owners themselves. One prominent operator said: "Since we can't get every miner in the state here to hear these talks for safety, we must go to them, and I hope to see the day when every local union in Illinois is represented at these meetings."

The suggestion "to go to the miner" was freely discussed as well as the need of emphasizing to the men that the safety movement is for the workmen, not the operators. This does not seem to be fully understood in some sections of the country, especially among the non-English speaking element. Realizing this, the operators of the state are going to approach "the man at the face" through the organization to which he adheres and teach him through that medium the truth of the old adage: "An ounce of prevention is worth a pound of cure."

Force vs. The Constitution

COL. THEODORE ROOSEVELT, former President of the United States, in testifying as a witness in the case of Attorney Wales against John Mitchell as President of the United Mine Workers, said that he, Colonel Roosevelt, while President of the United States was prepared to use the United States Army to seize the anthracite mines of Pennsylvania, if the operators had refused to arbitrate the coal strike in 1902. This statement of Colonel Roosevelt was a surprise to both his political friends and enemies. His friends have lauded him as a forceful man, but they had no idea that his forceful character would lead him to contemplate a gross violation of the fundamental law of the country. Some of his friends will in all probability condone his admitted policy, but the great body of patriotic Americans, men who respect the Constitution will agree with the strong remarks of Hon. Alton B. Parker, in his address to the graduates of the Yale Law School on June 15.

In criticising Colonel Roosevelt's policy in this matter, Judge Parker, former head of the New York Court of Appeals, and a one time candidate for the Presidency of the United States, spoke as an American, and as a well-informed jurist, and not as a partisan politician. His remarks were as follows:

"Something is radically wrong in the mental processes of the electorate, or else patriotism is at its last gasp when, with hardly a whisper of protest, a retired chief executive may brag to representatives of the people of his treasonable scheme to intrude upon state rights, and violate otherwise the fundamental law by establishing a military receivership over coal mines, pending a strike, admitting without a suspicion of decent shame that he had well considered that his offence might be impeachable if committed—impeachable, of course, only because the acts meditated would have been unconstitutional and lawless.

"Our forefathers, clear of head and far of sight, anticipated just such vicious attacks by those in power, and sought to insure to us a government of laws and not of men, and through their wisdom such a government is ours for a little vigilance.

"The country needs a host of clear headed, active men in the electorate, who shall discern and brand with the infamy it deserves every assault upon the constitutional foundation of our libery, prosperity, and happiness.

"The duty and opportunity of vigilance rests not alone upon federal and state officials, not alone upon the courts, but primarily and most fully upon the men with the ballot."

Breaking Colliery Rules

THE verdict most generally rendered by a coroner's jury after mine explosions is that some man by disobeying the colliery rules caused the disaster. People not aware of the thought given by officers of collieries in formulating rules to the end that no harm may come to the men or the property, have sneered at these verdicts, claiming they were rendered to whitewash the company. Shortly before the Eccles No. 5 explosion occurred, a miner informed his wife that another miner was breaking the rules, endangering the lives of all in the mine and if he did not stop his actions, he would have to report him. The slogan "safety first" will amount to little if one miner risks his life and possibly all the lives in a mine, because he is negligent in reporting an infraction of rules. Coal operators when hiring inspectors do not have in mind the policing of their mines, in fact company mine inspectors are a recent innovation and are hired to examine different parts of the mine and to give advice to men in order to minimize local accidents. It is not the duty of these men to see that the mine rules are obeyed any more than it is the duty of the miner; however, if an inspector reports a miner who breaks the rules, it is not considered amiss, while should a miner report a misdemeanor he is considered a mischief maker. Under the slogan "safety first" every mine worker must be an inspector or the plan will not work, and operators and foremen should impress on miners that he who knows of another breaking rules and does not report him is as guilty as the man who breaks the rules.

Reports covering the disregard of rules should be made a part of the colliery rules, and all false sentiment relative to reporting infractions of rules talked out of men. Much is said about mine officials keeping strict discipline, when miners will know of nine men breaking rules where a mine official finds one. Whatever precautions are adopted by coal companies to lessen accidents will prove futile until they educate their employes to assist in the common cause.

Responsibility

"JOHN, that's a bad piece of top there. Set a prop under it at once, or you'll be caught." This was the mine foreman's order as he left the chamber. "Come on, Bill; we'll load this wagon, and then set the prop. That piece has been loose for 2 days, and I guess it'll stay up a little longer," said the miner to his "butty."

An hour afterwards the crushed, lifeless form of the miner was taken to his home. A widow and several dependent children suffered the loss of one dear to them, and were doomed to years, if not a lifetime, of poverty and privation. The protector of the family was gone. His death was unnecessary. Somebody was to blame. Who? Almost every mine accident due to a fall of roof or top coal is preventible. That such accidents occur is somebody's fault. Sometimes the mine foreman sees the danger and warns the miner; sometimes the danger becomes imminent when the foreman cannot see it. He cannot be in all working places at the same time. He can order precautionary measures. He cannot always see his orders immediately obeyed. There may be times when the foreman is at fault. In most cases the fault is due to the procrastination, or recklessness of the victim. The remedy is *constant vigilance and prompt action on the part of the miner.* The mine foreman who does not keep this fact constantly in the minds of his subordinates, is, morally at least, responsible for such accidents.

PERSONALS

J. W. Jeffrey, a son of J. E. Jeffrey, founder of the Jeffrey Mfg. Co., has been made vice-president of the concern.

Garner Fletcher, chief engineer for the Consolidation Coal Co., at Somerset, Pa., has been made general manager of the Miller's Creek division, succeeding G. M. Gillette, who has been transferred to the Elk Horn division.

John M. Roan, formerly state safety superintendent, through a reorganization of the Mining Department of the Ohio Industrial Commission, becomes Chief of the Mining Department, and J. C. Davies, the former incumbent, becomes his first assistant. The new chief has had a varied experience in the coal business.

C. L. Cassingham, of Cleveland, Ohio, has resigned as president of the Goshen Coal Co., with offices in Cleveland and mines in the Tuscarawas field of Ohio. He will devote his time to the opening and development of his properties near Charleston, W. Va.

C. A. Andrews, head of the C. A. Andrews Coal Co., of New Orleans, has been elected vice-president of the Maryland Coal and Coke Co., an Alabama mining concern which recently took over the business of W. G. Coyle & Co. in New Orleans.

J. W. Galloway has been elected president of the Maryland Coal Co., of West Virginia, vice W. H. Ziegler, resigned.

The Monongahela Coal Co. has been incorporated in West Virginia, with headquarters at Fairmont. Capital stock is $500,000 and the incorporators are: J. A. Clark, Harry B. Clark, T. F. Robey, C. H. Waggener, and John M. Flanagan.

The Kentucky-Harlan Fuel Co. has been organized at Louisville, Ky., to take over the former hold-

ings of the Wilhoit Coal Co. The officers of the new concern are: Roy Wilhoit, president; Henry T. Davidson, vice-president; and C. I. Hitchcock, secretary-treasurer. The mines are in Harlan County, Ky.

The property of the East Jellico Coal Co., consisting of 2,800 acres of land in Knox and Bell counties, Ky., upon which there is a mine in operation, recently passed into the hands of new owners, who have organized the East Jellico Mining Co. M. G. Yingling, of Lexington, Ky., is president and treasurer of the new concern; C. F. Swetner, of Cincinnati, is vice-president and secretary; and J. B. Marsee, of Tinsley, Ky., is general manager. The company is planning to acquire additional property in that section and extend its operations.

Edward d'Invilliers and his associates, Walter Gilman and J. B. Dilworth, have made an inspection of the coal and coke properties of the Lafollette Coal, Iron, and Railway Co., at Lafollette, Tenn., in the interest of the bondholders, the Electric Corporation, Old Colony Trust Co., and the American Trust Co., all of Boston, Mass.

B. E. Purser, recently appointed general superintendent of the mines of the Woodward company, it is reported will have complete supervision of all the mines in both ore and coal divisions.

R. H. Gillespie, of Vinita, Okla., and Andrew Voyles, of Woodley, Okla., have secured leases on 10,000 acres of coal lands near Bluejacket, Okla., following the discovery of promising coal deposits.

John A. Bell has been elected the president and a director of the Carnegie Coal Co., of Pittsburg, succeeding R. P. Burgan. Mr. Bell is best known as a successful banker in Pittsburg and western Pennsylvania, but he has had much to do with the development of the coal industry in the Pittsburg district.

Frank D. Rash, vice-president and general manager of the St. Bernard Mining Co., in the western Kentucky field, with headquarters at Earlington, has been elected vice-president of the Kentucky Manufacturers and Shippers Association.

Samuel Dean, of Delagua, Colo., sailed from New York in the "Oceanic" for Europe on May 23. Before sailing he visited mines in Illinois and Pennsylvania and expects to examine collieries and processes connected with mining in France, Belgium, Germany, and Great Britain.

On May 9 at the annual meeting of the South Wales Branch of the Association of Mining Electrical Engineers, Sydney Walker was presented with a testimonial, in the shape of a handsome gold watch, by the members of the Branch, "as a token of their esteem and respect," in connection with his presidency for the first 4 years of the existence of the Association. The watch bears an engraving to the above effect; and was presented by the president of the Branch, Mr. Godfrey Willais, of Aber Pergwm, a mine owner in Glamorganshire.

The Consolidated Indiana Coal Co. announced the appointment of Willis P. Thomas as general superintendent of the Iowa district of that company, with headquarters at Electra mine, near Melcher, Iowa, in full charge of the operation and maintenance of the property.

Joseph Struthers, Ph. D., announces that he has accepted the office of second vice-president of the Johnson Electric Smelting Co., Inc., controlling the American rights of the Johnson electrothermic process for the treatment of zinc ores and zinciferous lead and copper ores with offices at 18 East 41st Street, New York, N. Y.

Dr. John J. Stevenson, professor of geology at New York University, and Dr. I. C. White, state geologist of West Virginia, recently visited the anthracite region in the vicinity of Pottsville.

Dr. E. A. Barlow, ex-president of the Canadian Mining Institute and provincial geologist, was a victim of the "Empress of Ireland" disaster.

Prof. Robert H. Richards was in the first graduating class of the Massachusetts Institute of Technology, and has been identified with the Institution for 46 years. His wife was, we believe, the only woman "mining engineer," in the United States at least, who belonged to the American Institute. Mr. Richards receives the benefits of the Carnegie Foundation and will be made Professor Emeritus.

J. A. Cunningham, of Ashland, Ky., motored with friends from Charlestown, W. Va., to South Bethlehem to attend the Lehigh commencement exercises.

A. W. Calloway, president of Davis Coal and Coke Co., joined the West Virginia Mining Institute at its meeting in Cumberland, Md.

W. M. McKee, at one time with the Jeffrey Mfg. Co., of Columbus, Ohio, is now general manager of the Coal Mine Equipment Co. with offices at 332 S. Michigan Avenue, Chicago, Ill.

B. P. Manley, late of Denver and Salt Lake City, has assumed the position of general manager of the American Fuel Co., of Utah, and subsidiary interests.

W. A. Thomas, who for several years has been Commercial Engineer in charge of all sales of mines and apparatus for the Westinghouse Electric and Mfg. Co., resigned his position June 1, and has taken up the practice of consulting engineer in Pittsburg, Pa., with offices in the Second National Bank Building.

J. H. Rittenhouse & Sons, civil and mining engineers, have moved their offices to 721 Connell Building, Scranton, Pa., where they will continue the practice of general surveying, experimenting, testimony, investigating royalty accounts and the safety of property.

Charles F. Eiker, treasurer of the Perolin Company of America, died suddenly in Cleveland, June 6. He had apparently been in the best of health the evening before when he left his home in Chicago to fill a business engagement.

Harry Cameron has been appointed general manager of the mines of the Cambridge Collieries Company at Cambridge, Ohio, vice P. Y. Cox, deceased.

The Colliery Engineer

COAL MINING & PREPARATION

Western Montana Coal Fields

Some Notes on the Tertiary Coals of Montana, With Descriptions of Some of the Mines that Are Now Producing

By Leroy A. Palmer*

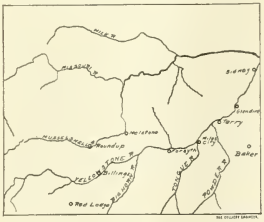
NEARLY half of the great rolling plain that stretches eastward from the Rocky Mountains and their tributary ranges in the state of Montana is underlain by coal or lignite. This has been known since the settlement of this part of the country, but in early days there was no market and no railroad had there been one, and, moreover, the first settlers were agriculturists. Their eyes first saw the abundant forage of the region, and here sprang into being one of the greatest cattle countries on the globe. The coal couldn't help but be seen, but its value occurred to the settlers only as supplementary to their great industry, and, except for a few fields, this coal lies in the ground today as it always has, except where it has been mined in a desultory manner to supply nearby ranches or for local use at some town. Even now it is a notable fact that towns in this region, situated in the midst of coal fields that appear well-nigh inexhaustible, are bringing practically all of their coal hundreds of miles from the better developed fields to the westward.

These observations are confined to fields adjacent to the Yellowstone and Musselshell rivers and their tributaries, although the large fields north of the Missouri River are fully as important as those mentioned.

Since 1906 the great size of these deposits has brought them to general attention, the land has been withdrawn by order of the President and much of it has been classified and restored to entry. The area under consideration is part of a much larger one which extends northward from the North Platte River in Wyoming between the Black Hills and Big Horn Mountains across Montana and into Canada.

HEADHOUSE, EAST SLOPE, NORTHWESTERN IMPROVEMENT CO.

MODERN CLIFF DWELLERS NEAR ROUNDUP, MONTANA



PART OF MONTANA COAL FIELD

Westward in Montana it extends nearly to the Yellowstone where it runs northward in Central North Dakota. The United States Geological Surveyors estimated this gross area as 100,000 square miles. Rowe*, who first attempted a comprehensive study of the coals of the state, placed the area of Cretaceous and Tertiary coals at approximately 50,000 square miles.

Geology.—The fields under discussion all lie in what has been designated as the Fort Union formation from a particularly favorable exposure at Fort Union, an old military post at the mouth of the Yellowstone River, or in the Lance formation, so named from Lance Creek in Wyoming. Most of the workable beds are in the Fort Union, while the Lance beds are characterized by lenticular form and lack of persistence. The age of these formations has been the subject of much study. Rowe places the Fort Union in the Cretaceous and cites Chamberlain and Salisbury to the effect that it represents the transition period between Mesozoic and Cenozoic times. Since these authors have published

*Mining Engineer, San Francisco, Calif.

*J. P. Rowe, Montana Coal and Lignite Deposits, University of Montana, Missoula, Mont.

their views the United States Geological Survey has made a comprehensive study of the subject which leaves no doubt that the Fort Union is of Eocene time. The Lance, which underlies the Fort Union, has not been definitely located geologically. It may be either early Eocene or late Laramie.

In general both formations are clays and sands. The Fort Union is principally light colored, yellow and gray, but with darker colored members at the base; while the Lance is darker in color, ranging to dark brown and even black.

Beds of lignite and subbituminous coal are abundant in the Fort Union, although many of them are too thin to have any commercial value. One exposure of 288 feet in the Sentinel Butte field of eastern Montana and western North Dakota shows 18 feet 4 inches lignite, although from the fact that this is scattered through 20 seams only a small part is workable. It is by no means uncommon, however, for many seams of good thickness to be found within such a depth as to make all of them easy of extraction.

Such a section is found at Red Lodge, in the Carbon County field, where in an exposure of 803 feet there is 108 feet 1 inch of coal in 11 seams, only two of which are less than 5 feet in thickness, these having thicknesses of 2 feet 2 inches and 4 feet 6 inches, respectively, and one seam showing a thickness of 25 feet 2 inches at the point where the section was measured. This proportion of 1 to 7.5 through such a range is one rarely equaled. Another similar instance is shown at the Mammoth bed in the Bull Mountain field where in an exposure of 27 feet 9 inches there are 13 feet 6 inches of coal in three seams of 2 feet, 3 feet, and 8 feet 6 inches, respectively.

So far, development on any scale of magnitude has been confined to the Bull Mountain and Carbon County fields. At these points the formation is such, in the matter of good roof and floor, as to permit of the extraction of coal on a large scale, and one company is operating in the Bull Mountain and several in the Carbon County field. In the eastern part of the state a good roof is a rarity, which has probably been a potent factor in retarding development in this locality. Mining in these fields has been practically confined to that which the settlers have done to supply their own needs, with an occasional mine for the sale of the product at a nearby town; but the most extensive of the latter which came to the writer's notice was only in 400 feet and, in general, the only coal that has been mined in this part of the state has been taken out in driving entries, which have to be tightly timbered, and no attempt has been made to turn cross-entries and rooms and mine on an extensive scale.

The Carbon County field lies near the Montana-Wyoming line at the foot of the Beartooth Mountains. It is usually spoken of as three fields, the Red Lodge, the Bear Creek, and the Bridger, of which the latter is in a formation older than the Tertiary. The district is thus separated geologically; and the Red Lodge and Bear Creek districts are distinct topographic units, as a high divide separates them and they are at a considerable difference in elevation due to the deep cutting of the valley of Bear Creek. The latter two, however, are the same geologically and strata accompanying the coal seams have been traced from one to the other.

The Red Lodge field is one of the largest producers in the state and also one of the oldest, development going back to some time previous to 1882. The Northern Pacific Railroad secured title to a considerable acreage on Rock Creek, and the Northwestern Improvement Co. has operated extensively at Red Lodge, but it is only since 1906, when the Montana, Wyoming & Southern Railroad built from Fromberg to Bear Creek, that the latter camp has had railway facilities, rail connection with Red Lodge being impracticable on account of the high divide and difference in elevation, although the terminals of the two railroads are within 3 miles of each other in a direct line.

The Fort Union formation occurs in these fields as sandstones and shales having a total thickness of 8,500 feet, in which the workable beds occur in a zone 825 feet thick with 5,700 feet of barren ground below and 1,975 feet above. The formation has been intruded by several thin dikes of camptonite, a mottled, dark colored rock consisting chiefly of augite crystals in a ground mass of plagioclase. The most prominent of these dikes, known locally as the "iron dike," shows just south of Red Lodge, where it has been cut by the workings of the East mine. No faulting occurred at the dike and the alteration caused by the intrusion extends but a few feet each side and is unaccompanied by anthracization.

About 3 miles south of Red Lodge a heavy fault with a throw of thousands of feet has brought up rocks from Archean granite to Carboniferous limestone, the latter surrounding the older formations and showing as a bold escarpment with striated and slickensided walls that rise hundreds of feet above the surrounding country and, of course, mark the limit of the coal in that direction. The northern limit of the field appears to have been reached in the vicinity of Red Lodge, as extensive prospecting a few miles north of that point failed to show coal that could be worked at a profit.

The coals of this field are subbituminous ("black lignite"), dull black, jointed and very blocky. They scratch with a decidedly brown streak, are rather soft and do not store very well although they are successfully used as fuel on the Northern Pacific Railroad.

Operation.—The Northwestern Improvement Co. is the only mining company operating at Red Lodge. It is outputting about 2,500 tons daily from two slopes, the East and the Sunset, using modern equipment in the way of electric lights, steel tipples, haulage, washery, etc.

The East slope, opened where the strata dip from 16 degrees to 20 de-

grees, is driven due south on an original dip of 12 degrees so as to cut the various seams, and as the work has progressed the dip has been flattened to conform to a corresponding change in the dip of the seams. The slope is about a mile long and, although the heavy covering of all alluvium makes it impossible to make deductions from the surface, the mine officials believe from the gradual flattening of the seams that the local formation is a syncline and that, as the work progresses, the seams will eventually be followed to the rise.

The Sunset slope lies about half a mile west of the East slope, on the opposite side of Rock Creek. It has been driven about 3,500 feet westerly.

These mines have encountered some water which is collected in a sump in each by sinking pumps and delivered to the surface by electric-driven Goulds horizontal triplex pumps. Room haulage is by locomotive and main haulage by cable unbalanced. With the exception of one mine in the Bridger field that is worked by longwall, all of the mines of the district are worked by the room-and-pillar method, and hand undercutting is the general practice.

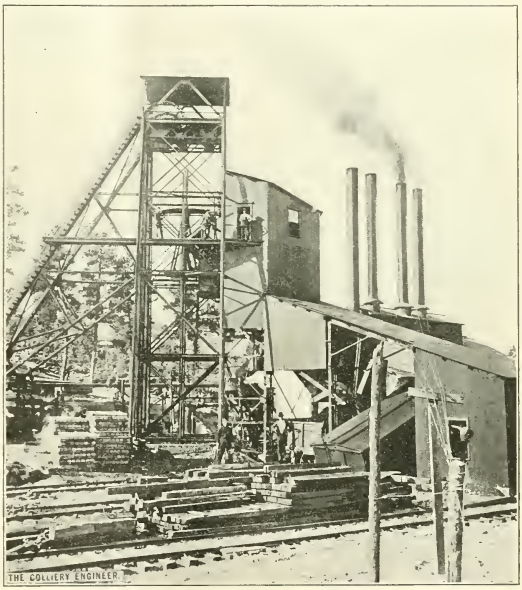
At the East slope, work has been changed recently so that the rooms are driven across the pitch instead of with it. This necessitates the driving of two cross-entries at right angles, one across the pitch and one from it with the pitch, the rooms being turned from the latter and thus simplifying the work of gathering.

Prospecting in the Red Lodge district has demonstrated the existence of 11 seams of coal which, at the point mentioned previously, measures as follows: No. 1, 11 feet 7 inches; No. 1½, 4 feet 6 inches; No. 2, 6 feet 10 inches; No. 3, 11 feet 2 inches; No. 4, 11 feet 8 inches; No. 4½, 5 feet 4 inches; No. 5, 12 feet 4 inches; No. 6, 5 feet 6 inches; No. 7, 2 feet 2 inches; No. 8, 25 feet 2 inches; No. 9, 11 feet 10 inches. Work is carried on at present in seams, 1, 1½, 2, 4, 5, and 6.

Bear Creek and Bridger Fields. The Bear Creek coals occur in the same formation as those at Red Lodge and more coal is taken out there for general sale throughout the state than from any other field, operations being conducted at about half a dozen different mines. The occurrence of coal in the Bridger field, about 12 miles northeast of Bear Creek, is somewhat different from that in the other districts in this field. The age of the Bridger coal has not been definitely determined. It is either late Montana or early Laramie, hence does not properly come within the limits of this discussion. The beds are not as thick as at Red Lodge, varying from 3 to 6 feet, but indications are that they are of considerable extent. Their occurrence is between shale and sandstone.

Analyses of air-dried samples from the different districts of the Carbon County field show as follows:

	Red Lodge, Seam No. 1 Per Cent.	Bear Creek, Seam No. 1 Per Cent.	Bridger Per Cent.
Moisture	7.34	6.40	5.78
Volatile matter	37.92	35.80	35.12
Fixed carbon	42.17	46.80	50.64
Ash	12.57	10.82	8.46
Sulphur	1.10	3.01	.65
B. T. U.	10,604	10,876	



Tipple at Republic No. 2 Mine, Montana

Bull Mountain Field.—Next in importance to the Carbon County is the Bull Mountain field, which extends from about 30 miles north of Billings to the Musselshell River. Roundup is the principal town and the center of coal mining activity. The field has only come into prominence during the last 5 years, or since the Chicago, Milwaukee & Puget Sound Railroad has furnished an outlet as well as a market for the coal. The Republic Coal Co., a subsidiary of the railroad, is the principal operating company.

The westerner, used to the Rockies, who first travels this field is prone to inquire, as did the writer, when he will come to the Bull Mountains. These "mountains" are, in reality, hills rarely more than 300 feet higher than the surrounding country, with prominent sandstone croppings that can be traced for miles without any sign of displacement.

While there are several seams of workable thickness, the proportion of workable coal does not approach that found at Red Lodge, when the entire area is taken into consideration; 24 seams, all told, have been demonstrated, but by no means all of these are of workable thickness over the entire field. The coal is lenticular although the beds are persistent over large areas. Very little of the area north of the Musselshell River and adjacent to the Bull Mountain field has been found to contain workable coal. The general structure of the field is a northwest-southeast syncline with dips up to about 13 degrees.

Three mines, the property of the Republic Coal Co., are in active operation and outputting 4,000 tons per day when working to capacity. All are working in the Roundup bed. No. 1, the first mine operated by this company, is a slope across the Musselshell River from the town of Roundup. This was worked until the property limits were approached when a combination of water and grasping owners of adjoining property effected its shut-down. The company then acquired rights on Half Breed Creek, built 5 miles of spur track and opened No. 2, bought the mine of the Roundup Coal Co. 2 miles west of town, which it designated as No. 3, and opened No. 4 4 miles down the river from Roundup. Nos. 3 and 4 are worked by slope, but No. 2, the mainstay of production, is worked by a shaft to a depth of 350 feet, where it cuts the Roundup seam where that has a northeasterly dip of about one-half degree.

The floor of the coal is irregular, forming numerous swales in which water collects. The pumping system, designed by Charles F. Brenn, engineer for the company, is unusual and interesting. Instead of installing a series of siphons or small pumps the water from all of these sumps is collected by suction from the station pump, some of these suction pipes being as long as 2,500 feet. There are two main suctions, one 6 and one 8 inches, which reduce to as small as 2 inches by the time they reach the farthest sumps. Each suction pipe is provided with a valve at the sump and this valve is closed by a float when the sump empties and opened when it fills. At the time of the writer's interview with Mr. Brenn the system had not been in use a sufficient time to allow of definite figures as to efficiency, but it appears feasible on the face. It certainly simplifies maintenance of the pumping system and should effect an economy in actual pumping costs, in that such items as slippage, leaks, packing, etc., of a number of small pumps are done away with.

All of the Republic mines are well equipped. No. 2 is especially so, with steel head-frame and tipple, good boarding houses and dwellings and other modern equipment. Near No. 2 is an interesting sight, where some of the foreign laborers have built homes for themselves by burrowing into the softer shales of the cliffs using the overlying sandstones for roofs and supporting them by sandstone walls, about as near an approach to "cliff dwelling" as one will find in this modern age.

The Bull Mountain coals are traceable down the Musselshell as far as Melstone, 30 miles below Roundup, but active work is confined to the vicinity of the latter place, except for some prospecting being done on an extensive scale at Japan, about 6 miles west of Melstone. The physical properties of the coal as well as the chemical composition, as shown by the following analysis, are very similar to the coals of the Red Lodge and Bear Creek districts. The first firemen on the railroad were brought from the Chicago, Milwaukee & St. Paul, and these men, used to the heavier coals of the central states, had poor success with the light, subbituminous coal, but by changing the design of the grates and firing heavily so that too much would not be driven out of the stack by the draft, good results were finally obtained.

An analysis of an air-dried sample from the Roundup bed shows:

	Per Cent.
Moisture	10.27
Volatile matter	29.51
Fixed carbon	52.31
Ash	7.91
Sulphur	.56
British thermal units	11,340

Welfare Work at Grant Town, W. Va.

By A. W. Herstine

One of the fastest independent base-ball teams in the Fairmont mining district is shown in Fig. 1. Since the opening of the season this team has lost but one game. Every member of this organization is employed at the Federal mine of the Federal Coal and Coke Co., at Grant Town, W. Va., 10 miles northwest of Fairmont, and the people of the community are justly proud that it is not necessary to go to other mines or outside their own community for suitable players, as has usually been the custom in past years.

The Federal Coal and Coke Co. have given their support to the Athletic Club and have under construction a modern club house for their use. In the near future it is expected a Y. M. C. A. building will be erected where the members of this organization will have the benefit of a model gymnasium together with reading rooms, classes in mining, and everything possible for the training of those desiring to prepare themselves for the future.

The Federal mine was recently inspected by a commission of experts appointed by the government of Nova Scotia, who pronounced it one of the best equipped mines they had visited in this country.

The policy of the Federal Coal and Coke Co. has always been to consider the welfare of their workmen while off duty as well as while employed in the mine. One of the

many things it is doing for the benefit of its employes is the erection of a grand stand at the ball grounds, and building a new court for those who prefer tennis to other pastimes. Already there is a public hall where dances and other public meetings are held. The company has built a number of new houses while others

with swings, seesaws, rolling barrels, slides, and other joy makers for youngsters is under construction, and before the summer is fairly begun will be one of the lively spots of this community.

The welfare of the community in general has been given considerable thought and attention as well as the

compressors; in fact new and up-to-date machinery in every department for the safe handling and mining of coal. All these improvements aid in safeguarding the employes and make their work less burdensome. The company owns 600 steel hopper cars and as the entire output is contracted for several years in advance, there is

Fig. 1 Grant Town Ball Team

Left to right, standing: J. J. McGraw, President, A. W. Herstine, R. Boyd, M. E. Wilbur, Auditor, G. H. Gefel, W. Kirchner, J. G. Belmont, C. A. Philippi, Engineer, J. McCormick, W. J. Hines, J. M. McKenna, Mine Foreman, J. W. Devison, Superintendent.
Kneeling: B. F. Morgan, Capt., C. Russell, G. Fluharty, J. J. Kirchner, Manager, H. Crowe, H. A. Fultz, J. Hines, Thomas McGraw, Mascot.

are under construction, which show a wide departure from the usual type of miners' houses in that they have baths and other improvements. The company contemplates the erection of a bath house where the men employed inside the mine can wash and leave their working clothes before going home. Each man will have the use of two lockers, one for clean clothing and one for the clothes worn at work. The building will be fitted with 45 shower baths, 15 lavatories, also other necessary fittings, and 600 or 700 lockers. This feature will assist the wives and families in keeping tidy homes and yards, for which monthly prizes are awarded as follows: Three prizes for the best kept lawns; three prizes for the best kept gardens; and three prizes for best kept premises.

A brass band of thirty pieces recently organized is being supported by the Federal Coal and Coke Co. and it intends to erect a band stand for concerts during the summer months. A playground for children, pleasures for young and old. Fire fighting apparatus consisting of hose truck and chemical engine, adequate for any emergency is ready day or night with a trained brigade of fire fighters. The records show that there has been but one fire in the community within the past 5 years, which is presumably due to the use of electricity exclusively for lighting the houses as well as the streets.

For the protection of the mine workers two rescue teams have received training from the United States Bureau of Mines and a complete outfit of rescue apparatus is maintained by the company. There never has been occasion for apparatus of this kind and chances are remote that these men will ever be called at this mine, but "safety first" is the real spirit shown.

Among the recent improvements at the mine was the erection of a modern steel tipple which cost $50,000; a new fan and engine; new air and electric motors for gathering and hauling the coal, new air-

opportunity for steady employment. The company also maintains an up-to-date department store where only first-class merchandise is for sale. The community is not restricted to one store as there are several independent stores and Fairmont is but a few minutes' trolley ride from the town.

In the discussion which followed Mr. J. R. Campbell's paper on "Basic Coke" read before the Coal Mining Institute of America, Mr. E. B. Wilson thought the proper way to eliminate sulphur was by washing the coal or by the addition of sodium chloride which would act as an oxidizer and drive off the sulphur. He asked Mr. Campbell if he had experimented along the line suggested. Mr. Campbell replied that he had, and it worked almost perfectly in beehive ovens, but could not be used in by-product ovens, using the direct process for recovering ammonia, as it converted ammonia into ammonium chloride.

The New Weston Colliery

Of the Locust Mountain Coal Co., Near Shenandoah, Pa.—The Drainage a Unique Feature

By William Z. Price

ABOUT a mile west of Shenandoah, Pa., is situated the Weston colliery of the Locust Mountain Coal Co., the newest development in the anthracite region, and peculiarly enough, developing a small field which, until a comparatively few years ago, was unknown.

The coal which will be mined by the company is in two elliptical basins, lying almost end to end in an east and west direction. These basins lie to the north of the Shenandoah basin and this accounts for the fact that they were not previously discovered.

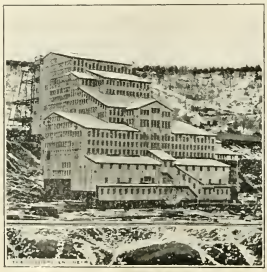
The entire property is leased from the Girard Estate, the royalty is based on the percentage of the selling prices of the coal, which is the regular method by which the Girard Estate's royalties are calculated.

Before offering the property for sale, the Girard Estate expended somewhere in the neighborhood of $18,000 on provings, with the result that the property was shown up thoroughly, and the Mammoth, Skidmore, Seven-Foot, Buck Mountain, and Little Buck Mountain seams were clearly and regularly defined.

The coal company feels that by conservative mining and the careful husbanding of all the coal, they can increase the tonnage estimated by the Girard Estate by fully 10 per cent.

The arrangement of the operation is unusual. The breaker, situated along the Lehigh Valley Railroad tracks, stands over the barrier pillar between Packer No. 3 and No. 4 collieries of the Lehigh Valley Coal Co. This position is secure, and since the Packer collieries are also on the Girard Estate, the location was obtainable. The coal for the breaker comes from two sources, the tunnel workings and the strippings.

Weston Colliery Yard, Packer No. 3 in Foreground



Breaker, Weston Colliery

The eastern strippings lie 2,000 feet northeast of the breaker. The eastern basin is being stripped at present. It is about 3,000 feet long, 500 feet wide in the middle and 300 feet at either end. The seams pitch 45 degrees on the south dip and 28 degrees on the north. The ones that will be uncovered and mined are the Mammoth, Skidmore, and Seven-Foot, measuring 50, 12, and 7 feet in thickness, respectively. To strip these three seams, the mining in the open will reach a depth of 170 feet. When stripping of the western basin is begun it will mean the uncovering of the Mammoth and portions of the big Buck Mountain only.

Removal of the cover in the east-

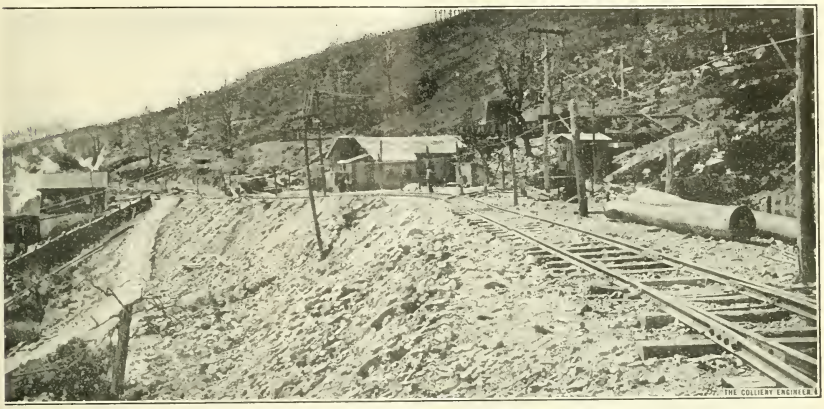
ern basin was begun in June, 1913. Three 70-ton Bucyrus shovels are at work and over 500,000 cubic yards of earth have been removed to date. All told, the cover to be removed will aggregate 4,000,000 cubic yards. The average daily excavation is 3,500 cubic yards. But little mining has been done so far, it amounting to about 100 cars a day. When the stripping is in full operation, three 18-ton revolving Bucyrus shovels will mine the coal. There are eleven 20-ton Vulcan steam locomotives in use. The dump cars are of the Kerbaugh type.

The coal is loaded into all-steel mine cars equipped with both tight and loose wheels, outside packed, a spring drawbar and a hand brake on each side. They weigh 6,200 pounds each and have a capacity of 135 cubic feet. A Vulcan locomotive hauls the coal to the head of a plane 3,000 feet southwest of the stripping.

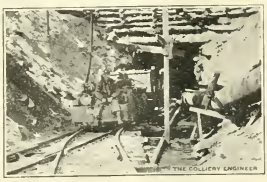
The plane is 1,800 feet long and double tracked its entire length. It is of but 4 degrees pitch for 900 feet from the top, increasing to 18 degrees for the remaining distance. This prevents the use of a gravity system, so a Vulcan electric hoist directly connected to a General Electric 440-volt induction motor, was installed. This is probably the only self-acting plane engine of its kind in the country. The motor supplies the power for the first 900 feet; then the grade of the track being so great, the incline becomes a gravity plane. A small air compressor similar to the traction type is attached to the hoist. The hoist itself has a governor which applies the brakes if the rope goes faster than 260 feet a minute. The maximum pull of the engine is 25,000 pounds or a capacity of 24 tons per trip. The stripping cars join those coming from the tunnel near the foot of the plane and run by gravity to the breaker.

Below the bridge shown at the extreme right is the entrance to the tunnel. It is 3,808 feet long, driven almost due north to the bottom measures and on through to the south dip of the Little Buck Mountain seam. It was started June, 1913, and finished in February, 1914. The average daily distance the tunnel was driven was 15.53 feet, the maximum for any 1 month being 513 feet. Water-Leyner drills were used for the work, the same men doing the work who drove the Laramie irrigation tunnel. The tunnel is single tracked, 12 feet wide, 7 feet clear of the rail, and has a drainage ditch 4 feet wide and 2 feet deep, on a 1-per-cent. grade. In the driving of the tunnel an Atlas storage battery locomotive was used to haul out the rock.

Sixty-seven-pound rails are used in the tunnel as compared to 60-pound about the stripping and 40-pound about the breaker. One General Electric 8-ton mine locomotive is used at present for tunnel haulage, but in the future instead of buying a heavier locomotive, they will use two of the 8-ton type with multiple control. The gangways in the tunnel workings will be driven in the Little Buck Mountain seam. Top rock is blown down, leaving a solid roof which requires a minimum amount of timbering. Rock holes



Entrance to Tunnel under Bridge at Extreme Right



Mouth of Tunnel, Weston Colliery

will be driven every 150 feet to the Buck Mountain and three rooms mined out in each panel.

The breaker was built and operated in less than a year. Coal was first dumped on April 8, 1914. It is essentially the same as the Beaver Brook breaker of the same company, situated at Audenried, Pa. The timbers forming the breaker are without mortise-and-tenon joints, tie-rods, bolts, and brackets having been substituted. There are but three power units, each 100-horsepower induction motors belted to a main line shafting, from which Dodge rope drives lead off to the various individual machines.

A feature in connection with the construction of the breaker that is noteworthy is that all shakers are of wood and driven by wooden connecting-rods. Everything about the shakers with the exception of the one at the top of the breaker is interchangeable so that it is only necessary to carry in stock, parts for one shaker. This is also true of all the gears whether used on elevators, moving platforms, or scraper line. All shafting, pulley sheaves, belt wheels on rolls, etc. are interchangeable. A conspicuous item is that there is but one elevator in the building and that is used in the re-preparation of the lip screenings.

The power house contains two 100-horsepower General Electric induction motors belted to double-stage Ingersoll-Rand air compressors, a 150-kilowatt rotary converter and a 10-horsepower induction motor geared to a 4″×6″ Deming duplex pump which supplies fresh water for the boilers of the shovels and locomotives at the stripping. A 35-horsepower induction motor geared to a 13″×10″ Aldrich triplex pump rehandles the wash water from the breaker and sends it through the building again. The water in the first place comes to the breaker from the drainage ditch in the tunnel and from the stripping. At the latter place a sump was made 200 feet long, 20 feet wide, and 20 feet deep. Two Aldrich triplex pumps, one 13″×10″, and the other 8″×10″ with 10-inch and 8-inch suction pipes, respectively, discharges into a 12-inch pipe which conveys the water to the breaker. Induction motors drive the pumps and the power comes from the Schuylkill Gas and Electric Co.'s plant near Hazleton.

An interesting fact in connection with this colliery is that there is no boiler house, no pumps in the mines, and when the stripping operations become deep enough, a bore hole will be drilled to the tunnel workings thus making the entire property subject to natural drainage.

An unusual arrangement for checking the presence of the men in the mine has been adopted at the Weston colliery. It is a clock scheme and simple in operation. Each man has a number. When a man goes to work in the morning he takes a card corresponding to his number from the file alongside of the clock, puts it into the time recorder and presses a lever. This marks the day of the month and the exact time. The card he then places in a file on the other side of the clock and in the event of his leaving the mine he reverses the operation. The clock is made by the Cincinnati Time Recorder Co. and one is installed for the breaker, one for the tunnel workmen, and one at the strippings. These completely eliminate a timekeeper at each of the three places.

Pumping Out a Mine

The Schooly mine of the Pennsylvania Coal Co., which has been flooded for 15 years, is being unwatered by two two-stage centrifugal pumps each of which will lift 2,000 gallons of water 375 feet in 1 minute. The pumping out of this mine began on January 27 of this year and will take many months to accomplish. The mine is 588 feet deep, and the water was lowered about 130 feet in the first 2 months of work. At 181 feet in depth the company began to pump water from the gangways and chambers as well as the shaft, and the work proceeded more slowly. At this depth is the Checker bed; at 311 feet the Pittston seam will be met; at 389 feet the Marcy bed; and at 581 feet the Red Ash coal seam.

The method followed in pumping out the mine is new and interesting. The pumps driven by vertical motors placed directly on top of them, are contained in iron tanks which form floats of sufficient buoyancy to sustain the weights of the tanks, pumps, and motors, but the tanks are suspended by wire ropes from the surface and these are paid out as the water recedes. These ropes are for use in case of emergency, and have proved a wise precaution. The water is pumped up the shaft through a fixed column pipe which is connected to the pump by a flexible rubber hose. When the hose, which must stand a pressure of 200 pounds to the square inch, is stretched to its full length, the pumping is stopped and another length of pipe is added to the column pipe.

The estimated water in the mine is 600,000,000 gallons, but there is an additional flow of 2,000 gallons a minute coming into the mine to be coped with. As there are other operations near this flooded mine, separated by barriers, the Pennsylvania Coal Co. does not want this vast body of water threatening its workmen, whether the operation is profitable or not. The two 10-inch streams which are contending with this huge quantity of water are making slow but steady progress, but the prize to be won is 7,000,000 tons of coal.

In the early days of the pumping the water in the main shaft got 20 feet lower than that in the adjacent air-shaft, and when the latter finally caved at the sides, the obstruction which was holding back the water gave way, the pump, motor, and men were hurled upward in the main shaft. Fortunately no harm was done, and the wisdom of having the wire ropes instead of relying exclusively on the buoyancy of the tanks was effectually demonstrated.—*P. & B.*

Longwall Mining in Ohio

A Description of the Methods Employed at the La Belle Shaft Mine at Steubenville, Jefferson County, Ohio

*By Wilbur Greeley Burroughs**

LONGWALL mining is being carried on successfully at the La Belle Shaft coal mine of the La Belle Iron Works, Steubenville, Jefferson County, Ohio. The coal mined is the Lower Freeport or "Rogers" seam, Allegheny series, Pennsylvanian system. A typical section of the Lower Freeport seam in this mine, is as follows:

	Thickness	
	Feet	Inches
Mixed fireclay and shales		
Sandstone	25	
Shale	17	
Coal	2	9
Shale binder		2
Coal		7
Hard fireclay	5	

The shale overlying the coal is tough and forms a good roof. The coal seam which dips toward the southeast .55 foot in 100 feet, has face cleats that strike N 21° 30′ E; while butt cleats strike N 68° 30′ W.

An average analysis of the Lower Freeport coal at the La Belle Iron Works mine is as follows:

	Per Cent.
Moisture and volatile matter	31.06
Fixed carbon	62.26
Ash	6.68
	100.00
Sulphur	1.36

Beneath the coal, the 5 feet of hard fireclay forms a floor that when wet will heave in the room-and-pillar system of mining, when ribs are being drawn; and it also will heave in longwall mining if the pack walls are not placed properly, but by keeping the pack walls in correct form no trouble with heaving of the floor is experienced.

The coal is reached by a shaft 200 feet deep which is lined with brick and concrete curbing down for about 50 feet, when solid rock is encountered. The hoisting shaft, which was put down between 1852 and 1855, is divided into three compartments, each 4 ft. 11 in. × 8 ft. 5 in., two compartments being used for hoisting, the third containing pipes and electric cables.

*Oberlin, Ohio.

Longwall advancing is the system of mining practiced in that portion of the La Belle Iron Works mine under consideration. At present there is somewhat over 1,000 feet of face, and 24 roadways in the two machine sections. Relative to results secured, W. D. Crawford, president of the La Belle Iron Works, stated: "We have had this system in operation since June, 1913, and in our thin seam of coal (3½ feet thick), have found it very successful, and can at this time see no reason why it is not the best system yet devised." Inasmuch as the room-and-pillar system previously had been used, the workings extending from Ohio under the Ohio River into Brooke County, W. Va., ample opportunity for comparison between the room-and-pillar, and the longwall systems has been afforded. Thus Mr. Crawford's opinion carries with it the authority of experience with the two systems, operations being conducted on the same bed of coal with conditions having a bearing on the mining of the coal remaining unchanged.

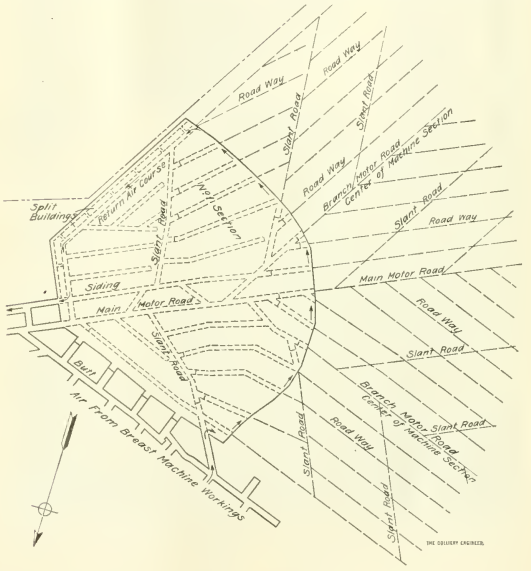


FIG. 1. METHOD OF LONGWALL MINING

In the longwall advancing used, the entire coal seam is mined on the first attack, the roof sinking upon pack walls which are built to keep the roadways open. One main haulage road extends through the property, as shown in Fig. 1, this, and all other roadways, being 9 feet wide and 7 feet high. Parallel to the main haulage road, a second road is maintained for use as a siding for

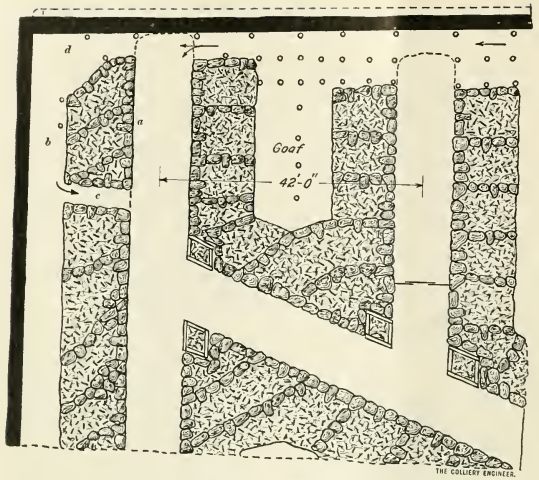


Fig. 2. Plan of Workings at Face

the cars of the main road. From the main haulage road, about every 800 feet, branch motor roads are turned in such a position as to follow the center of each machine section. Also, from the main haulage road, "roadways" are turned at 42-foot centers, which are extended parallel to the branch motor roads. From the branch motor roads "slant roads" are turned every 200 feet, or at such intervals as will best suit local conditions. The slant roads cut across the roadways, offering a more direct haulage from the face to the branch motor roads; and also allowing that portion of the roadway thus rendered useless to be abandoned. Where permanent roads meet, cribs are built to strengthen the corners as shown in Fig. 2. Partly decayed timber or old railroad ties are used, as old wood being springy, and yielding to the pressure exerted upon it, settles easily; whereas, new timber resists compression and thus produces a shear in the roof that causes falls of slate. When cribs are required at the face, which is not often, they are built of shale.

At the face where the coal is being mined with Jeffrey longwall mining machines, the men have a working place with a 42-foot center. As the longwall mining machine proceeds, undercutting the coal 3½ feet deep, a helper sets a prop, with a cap, at right angles to the roof and floor, every 9 feet, this interval being given so as to allow ample space between the props for loading the coal. These props are 4 inches in diameter. The cap for the top of the prop is from 2 to 3 inches thick, from 4 to 6 inches wide, and from 12 to 18 inches long, the long axis being set at right angle to the fissures in the roof. When a working place has been undercut, and the coal mined, the machine again commences to undercut the coal across the face. There is now one row of props, 9 feet apart, extending across the working place. A timber man precedes the mining machine, his duty being to make sure that the roof is safe, and also to set a prop half way between each of the props already set. This brings the props in the row 4½ feet apart. At the same time, the helper is again following the mining machine setting props 9 feet apart. This operation is continued until there are two rows of props and one row of props next to the coal, 9 feet apart, making in all three rows of props as shown in Fig. 2. On the further side of these rows of props from the coal is built the pack wall, which is composed of rock partings and similar debris from the coal seam, and material secured by brushing the roadways, which is done every second cut of the mining machine. Upon this pack wall the roof settles. As the mining machine starts undercutting for a fourth row of props, the pack wall is advanced, the back rows of props being withdrawn, although a few props in this back row may be left to steady the roof down upon the pack wall. No props are allowed to remain within 3½ feet of the side walls, for the weight of the roof on props thus left would bend and break the props, throwing the pack wall out of alinement.

The pack wall is 12 feet wide; the face wall is built every time the place is brushed, approximately 7 feet; the side walls are built true to line as indicated by chalk marks placed by the fire boss or mine foreman; and the space between the face walls is entirely filled with broken rock and debris. There are no back

Fig. 3. Finished Walls

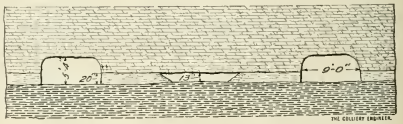


Fig. 4. After Complete Settlement

walls built, the idea being to protect the roadways by offering less resistance to settlement of the roof in the goaf, or open space between the pack walls, than at the roadway. Also, if a back wall were built and the floor started to heave, the floor would come up in the roadway just as quickly as it would in the solid goaf. But by omitting the back walls, the pressure, whether originating from the floor or roof, is relieved in the goaf, and the roadway remains intact.

Roadways nearest and parallel to the side of the mine or barrier pillar, as *a* in Fig. 2, are in danger of being blocked by the pack wall which intervenes between the side of the mine or barrier pillar, and the roadway; for if the pack wall is built solidly against the side of the mine or barrier pillar, when the roof settles the roadway offers the only place where the pressure can be relieved, and consequently the pack wall is pressed outwards, blocking the roadway. To protect the roadways from this mishap, an open space, *b*, is left between the pack wall and the side of the mine or barrier pillar. Thus, when the roof settles, the shear line follows the rib instead of the roadway, the pressure upon the pack wall is relieved on both sides, the pack wall is not pressed out into the roadway, and falls along the roadway are prevented. Also, at such intervals as are required for proper ventilation, an open passage, or split building, *c*, 3 feet wide, is constructed through the pack wall, connecting the open space, *b*, with the roadway. This insures thorough ventilation for all portions of the workings, for without the open space, *b*, next the side of the mine or barrier pillar, and the split building, *c*, gas might accumulate at *d*, where the air-current would penetrate but to a slight extent.

In mining, the coal is first undercut by electrically operated Jeffrey longwall mining machines, above the 2-inch shale binder. On the average, a cut 3½ feet deep and 85 feet long is made each hour; and this reckoning includes setting up the machine, sumping, and all of the usual delays.

An interesting feature of these Jeffrey mining machines is a system of pulleys, made especially for use in this mine, which enables the operator to work the machine as a shortwall machine at the end of the cut, thereby cutting the entire face without the aid of the usual pick or breast machine sumping cut.

After the coal is undercut, if the downward pressure exerted by the roof upon the upper bench of coal does not bring the coal down, the coal is shot, but only a very small amount of powder is necessary. This shooting is done during the night. After the top bench is loaded out, the shale binder left exposed is thrown into the gob, and the bottom 7 inches of coal is taken out. The lower bench is shot when necessary.

All haulage in the mine is done by electricity. The heaviest grade is 2 per cent., but the usual grade is about ½ per cent. A single track is placed in the center of the roadways. Sixty-pound steel rails are used in the main haulageway; in branch haulage roads, 30-pound steel; and in the roadways 16-pound steel. The miners push the cars to the slant roadways, where they are gathered by an electric locomotive, the empty cars being left at the nearest switch. Forty cars, each having a capacity of 1 ton of coal, are hauled in one trip by a 6-ton Jeffrey electric mine locomotive at the rate of 6 miles per hour.

Fig. 6. Tipple at La Belle Shaft Mine

The fan shaft, 15 ft. 6 in. × 7 ft. 6 in. inside dimensions, is located about one-half mile south of the hoisting shaft shown in Fig. 5; and in Ohio, 1,000 feet south of the fan shaft is an intake air-shaft, 16 ft. 6 in. × 7 ft. 6 in., inside dimensions; while on the West Virginia side of the Ohio River is another air-shaft, 12 ft. × 2 ft. At the fan shaft the

ventilation is accomplished by means of a 16-foot Robinson reversible fan, used as an exhaust fan, which is housed in a building of brick. This fan is run so as to furnish 60,000 cubic feet of air per minute, with the water gauge standing at .5 inch. In the mine, door regulators are chiefly used.

Fig. 6. Longwall Mining Machine

There is not much gas in the mine, but small as is the amount, every precaution is taken; and each morning a thorough inspection of the mine is made by the fire bosses before the men are allowed to enter.

In order that the mine workings be kept free from water, pumps are kept in continual operation, a description of these pumps being as follows: One 10″×8″ triplex pump, that is driven by a 40-horsepower Westinghouse motor; one 6-inch rotary pump, driven by a 50-horsepower Westinghouse motor; one Deming Co., 8″×8″ triplex pump, driven by a 30-horsepower Westinghouse motor; and for emergency, one Cameron steam pump, 18″×36″ steam end, and 8″×36″ water end.

The coal on reaching the hoisting shaft is elevated on a self-dumping cage, Vulcan steam hoist being used, to the tipping floor of the steel tipple which rises above the hoisting shaft, as shown in Fig. 5. The coal is dumped and delivered through a chute into the weigh pan where it is weighed run of mine; and this system of weighing and paying has been used during the last 10 years. The coal is next passed over a 1¼-inch bar screen, the lump either going directly to the storage bin, or, if desired, it is sent through one or both of two roll crushers, one made by the Link-Belt Co., the other by the Scottdale Co., where the lump is reduced to any degree of fineness required. The coal that passes through the 1¼-inch bar screen goes to the storage bin. The three grades of coal thus made, run of mine, lump, and slack, are all used by the La Belle Iron Works, the coal being conveyed from bins by steel hopper cars hauled by electric locomotives, to mill pockets, from which it is placed in the furnaces, so that after the coal is loaded at the working face in the mine, it is never touched by shovel.

The mine is operated every working day in the year, except one-half day on pay Saturdays, of which there are 24 in the year. The planning and operation of the longwall mining described in this article, is in charge of R. W. McCasland, superintendent of the La Belle Iron Works mines, and to him the writer is indebted for information, drawings, and photograph of the La Belle Shaft tipple, contained in this article. The writer also wishes to make acknowledgment of the courtesy of W. D. Crawford, president of the La Belle Iron Works, by whose permission the article was prepared.

The Mining Engineers Association

Mining engineers and metallurgists whose professional engagements take them much abroad must have often felt the necessity for a reliable agent in London who would receive and forward letters, select, buy, and dispatch any instruments or other articles they might require, secure houses, flats, apartments, or offices against their return, arrange for suitable schools for their children, buy or sell stocks and shares, and, in fact, carry out any of the thousand and one little commissions which the man abroad finds so difficult of execution unless he is prepared to tire out the patience of his best friends at home. To obviate this unpleasant proceeding the Mining Engineers Association has been formed and will not only do for its members all that has been stated, but a good deal more—plus insuring the said member's life for £500 against accidents—and all for an inclusive fee of one guinea per annum, or fifteen guineas for a life membership. The offices of the Association are at 18 Eldon Street, E. C., and the Managing Director is Mr. Geo. Safford, formerly business manager of the *Mining Journal* and author of "Who's Who in Mining and Metallurgy." He needs no introduction to mining men at home or abroad and his knowledge of their requirements is founded on a long and practical experience.—*The Mining News (London).*

The volume of the 10-mile rocky crust of the earth, including the mean elevation of the land above the sea, is 1,633,000,000 cubic miles.

One per cent. of the contents of the oceans would cover all the land areas of the globe to a depth of 290 feet.

The Eccles Mine Explosion

Conditions Existing at the Mine Before the Explosion—Methods of Working—Results of Investigation

Written for The Colliery Engineer

ECCLES, where the mine explosion occurred April 28, is in Raleigh County, W. Va., about 4 miles from Beckley, the county seat, and is reached by the Virginian Railway or the Piney Branch of the Chesapeake & Ohio Railway. The coal mined is the New River semi-bituminous coking coal of the Pottsville series, and is considered to be the same as the Pocahontas smokeless coal. Two beds, the Beckley and Sewell, are worked at Eccles. The Beckley seam which is about 520 feet below the surface, has the following section: Coal, 1 foot; bone, 2 inches; coal, 2 feet 3 inches; slate, 8 inches; bottom coal, 2 feet 4 inches. Total thickness, 6 feet 5 inches. The roof is sandstone with about 1 foot of draw-slate above the coal; the floor is fireclay with sandstone immediately below it. An approximate analysis of the Beckley seams is: Moisture, 3.2; volatile matter, 15; fixed carbon, 78.1; ash, 3.7; sulphur, .7. It is in this seam at No. 5 shaft that the explosion originated and the bulk of the damage was done.

The Sewell seam at Eccles is about 254 feet above the Beckley, and is worked through No. 6 shaft although this shaft goes down to the Beckley seam. The Sewell bed varies in thickness, being thicker in the southern than in the northern part; for example, at this mine, the low section has 4 feet 5 inches of clean coal; the middle section 2 inches of bone and 4 feet 8 inches of coal; the high section 7 inches of bone and 4 feet 11 inches of coal. The roof of this seam is jointed and weak in places, while the floor is fireclay above hard sandstone. An approximate analysis of the Sewell bed is 3.71 per cent. moisture, 13.74 per cent. volatile matter; 79.81 per cent. fixed carbon; 2.74 per cent. ash, and .59 per cent. sulphur, this composition making it one of the best smokeless coals in West Virginia.

Eccles is one of the two large mining properties owned by the New River Collieries Co., the other being the Sun, in Fayette County. Franklin B. Guiterman, E. M., is president and F. P. Bayles, general manager.

Of the six shafts on the Eccles property, Nos. 5 and 6 are the ones of special interest because of the explosion, which occurred about 2:30 P. M., April 28, in which 180 men lost their lives. The two shafts being connected by an airway, the blast was transmitted to the Sewell bed in No. 6 shaft and eight men were found dead at this place. At the time of the explosion 73 men were at work in the No. 6 mine, and with the exception of the eight mentioned all the others survived. The force of the explosion or possibly the bad air which did the damage seemingly did not pass beyond No. 6 shaft; all on the other side of the shaft were uninjured. At No. 5 mine 172 men were killed, none escaping, making the total killed 180. As the mine was quite busy on the day of the explosion, a number of loaded mine cars were standing at the shaft bottom and these were thrown by the blast into the hoisting shaft, making it difficult to clear away so as to get inside the mine. One cage was thrown up into the head-frame, where it lodged, not quite reaching the sheave wheels, thus leaving the hoisting gear intact. The explosion doors of the 18′×7′ Jeffrey fan were blown off, but otherwise the fan was uninjured, and was stopped only so long as to fix the explosion doors and reverse the direction of the air-current. At 10 P. M. it was in working order. Soon after the explosion L. B. Holliday, mine inspector, of the 9th West Virginia District, arrived, and the rescue of the miners in No. 6 was commenced and carried out effectually with the aid of Thomas Donaldson, mine superintendent. In the meantime, assistance was offered by miners from the company's nearby operations also from miners in the vicinity, and these Manager Bayles organized into rescue crews. He also organized a refreshment bureau where those who were working in the rescue parties could be fed. At this improvised free restaurant the meals were excellent and preferred by the mine inspectors to those they obtained at boarding houses in the vicinity. Every one about the plant seemed to be endowed with some natural talent which could be turned to useful and helpful channels; even the school teacher became a waiter, while one of the company employes became an adept in soup making, ham and egg frying, coffee brewing, etc. This pleased Mr. Guiterman because there were 200 rescuers, and more who must be fed, as they had exhausting work to do on short shifts of 2 hours. As No. 5 was the downcast and No. 6 shaft the upcast, the rescuers could make no headway through the airway connecting the two shafts, even after the air-current had been reversed, but by Wednesday evening No. 5 shaft was cleared to within 60 feet of the bottom. This was slow work and it was not until Thursday morning that the shaft bottom was reached and the shaft guides repaired so that men could enter the No. 5 workings. Here the rescuers were hampered by water, the pump pipes having been broken and the pumps put out of commission.

Chief Mine Inspector Henry, who was then in charge of the work, commenced the restoration of the air-current, cleaning up and securing the roof by timbers. Electric pumps were installed in the meantime, but the rescuers were greatly hampered by water and debris, especially the helmet men from the Bureau of Mines.

The air was found to be fairly good when the bottom of the mine was reached and the use of canaries was unnecessary. The company uses brattice cloth in the mines and was fortunate in having a carload or more on hand to make temporary air stoppings, and so hasten the recovery and location of the bodies. Those found were not much burned, their deaths for the most part being due to asphyxiation and violence. Had it been possible to enter the mine, some lives might possibly have been saved; as it was, all hope of reaching any that might be alive was abandoned on the evening of the 27th.

The surface plants at these mines are well constructed and substantial, the engine and boiler houses being separated and made of dimension stone. The hoisting at No. 5 is accomplished by a first-motion modern Vulcan engine, Jeffrey self-dumping cages being used in the hoisting shafts. Back of the hoisting engine room is another room where the dynamos are installed, for the electric motors, pumps, and lights. Two 7″ × 10″ electrically driven Deane pumps drained the mine and delivered water to the sump where it was raised about 520 feet by two Cameron steam pumps 18 in. × 18 in. × 13 in. In the No. 6 shaft, a triplex electric driven Deane pump raises water 367 feet from a lodgment in the shaft to tanks on the hill. This arrangement furnishes a fire and domestic supply of water to the town of Eccles.

As shown by the map, the double-entry system of mining is followed, double rooms 24 ft. wide on 60-ft. centers being driven with track in the center. In order to avoid driving the rooms to the dip in the north right section of the mine, the cross-entries are driven on a slant with the main entries; the rooms on north left entries, however, are driven to the rise. In the southern section of the mine, the entries are driven to the rise and are turned at right angles to the main entries.

Mining is carried on both by picks and machines. Pick miners are supposed, under the rules, to undercut their coal to a depth equal to the height of the seam, drill the shot holes to a depth not to exceed the undercut, charge the holes with Monobel No. 2 permissible explosive, tamp the explosive with clay, and fire the shot any time during the day.

Machine miners undercut the coal, after which company shot firers drill, load, and shoot the holes. Two inspectors travel about the mine to see that the men are working under safe conditions and are observing the rules.

In the future it is probable that the Kansas system of shot firing will be put in practice; that is, no shooting will be allowed during the day and shot firers will do the work after all are out of the mine. For more than 20 years electric undercutting machines have been in operation, and during that time the writer has been unable to find a single instance where an explosion has been traced to places they have undercut, while a number of explosions have been traced to the working places of pick miners.

In some cases at Eccles, miners have disregarded the rules referring to undercutting and shooting off the solid, and in other cases they have purchased and used prohibited explosives. When this has been discovered the men have been laid off for a definite time and for a second offense have been discharged.

As gas exuded from each working face according to former Chief Inspector Laing, to ensure ventilation reaching the face, curtains were hung in cross-entries before new rooms and the air was forced to travel by brattice to within 12 feet of the face. When the first breakthrough was completed between adjacent rooms, the curtain was removed and the brattice placed so that the air-current would travel through the breakthrough and then to the room face. After the room had been advanced sufficiently for another breakthrough the first was closed with boards. In the entries the air stoppings were of stone and mortar and, in places, of brick. Practically all of these stoppings were blown down, some falling in one direction and others in a contrary direction, which would indicate that the explosion was traveling in both headings. It was reported that the mine was badly wrecked, that is the roof came down generally throughout. This it is understood was only true in entries where timber supports were knocked out, and in general the rooms were not badly damaged by falls. Overcasts and doors were demolished, which is usually the case in mine explosions. The mine was reported in newspapers to be on fire, a mistaken idea originating, no doubt, because of the heat in the mine and the bad air. No fires were found, which as an argument does not favor a dust explosion, where the partly coked coal dust becomes red hot and agglomerating often starts fires in places where it falls. Another matter which points to this being a gas explosion for the most part is that it extended generally throughout the mine, going with the air-current as well as against the air-current, reaching to the room faces and not taking a direct route through the entries to the shaft. The second explosion which occurred from 5 to 12 minutes after the first may have been a dust explosion.

The writer has been informed that very little coked dust was found in the mine, also that after the rescuers had gained an entrance they were able to restore ventilation quickly and explore the mine without the use of helmets.

Inside haulage was mostly by electric locomotives; Westinghouse 5-ton gathering motors being used on side entries and 13-ton Westinghouse motors on main haulage entries. A few mules were used in the mine for haulage purposes, but not many, although the mine was capable of producing 1,500 tons of coal daily.

There might be several theories advanced, any one of which under favorable conditions might have

caused the accident. The theory of its being a purely dust explosion is untenable, not alone because the roadways were watered, but because the indications following dust explosions were not much in evidence. From the positions in which the bodies were found the explosion seems to have been general throughout; or else the men moved backwards to escape afterdamp until trapped at the faces where they perished.

From testimony given at the inquest by several men who had explored the mine, including miners and company officials, the coroner's jury found that the explosion originated in the southeastern section of mine No. 5, where a barrier pillar had been left between entries to answer as a stopping until an overcast could be constructed to split the air.

Map of Eccles Mine

It was found from the testimony that Seth Combs, a contracting miner, probably caused the explosion by blowing the barrier pillar open and thus causing a short-circuiting of air, and an accumulation of gas which later was exploded by an open light.

Fire bosses who examined the mine the morning of the explosion testified that the barrier was intact when the men entered the mine. It was assumed that this miner knocked a hole in the pillar in order to shorten the distance he had to travel between two contracts in the same section of the mine, one each side of the pillar. There seems to be no question but that those most interested tried to reach the cause of the explosion, and while the jury were convinced that their verdict was as nearly conclusive as the testimony would warrant, there are

some skeptics remaining who evidently disagree with the jury as to the cause of this accident. After 2 days of earnest investigation and deliberation the jury rendered its verdict about as follows: John Adams and 171 other men who were killed in shaft No. 5 at Eccles, on April 28, came to their death by an explosion of gas. The accumulation of gas, in mine No. 5, due to a short circuit of air in the southern section of the mine, was fired by an open light and the explosion followed.

They also found that eight men in No. 6 mine came to their death by afterdamp produced by an explosion of gas and dust in No. 5 mine.

West Virginia used 11 miles of box cars in 1913 to break 66,000,000 tons of coal, i. e., 1,550 standard box cars containing 10,000 pounds of explosives.

Movable River Tipple

Arrangement for Loading Coal into Boats on Ohio River by a Tipple Which May Be Raised or Lowered According to Height of Water

Written for The Colliery Engineer

THE exceptional high water which prevailed in the Ohio River Valley in 1913, and which may or may not occur again, induced the Ohio Valley Coal and Mining Co. to adopt a movable tipple at DeKoven, for river shipments of coal.

The tipple is about 1¼ miles up the river from Caseyville, shown in Fig. 2, and about 2 miles from the Western Kentucky Coal Co.'s tipple shown in Fig. 3. Caseyville, before the advent of the Illinois Central Railroad and the floods, was an important river town, but at present the bank has the back end out and the front end in a dilapidated condition. The height of the flood of 1913 is shown plainly on the Post Office to the rear and left of the bank. This illustration and that of the Western Kentucky Coal Co.'s tipple, Fig. 3, are given so that some conception of the recent flood may be obtained by operators in other coal fields of the country. In 1913 the Ohio River rose 48 feet or until it reached the eaves of the house covering the Western Kentucky's river tipple.

DeKoven is in Union County, Ky., on Illinois Central Railroad branch which connects Evansville, Ind., with Princeton, Ky. At this place the Ohio Valley Coal and Mining Co. has an extensive slope mine capable of producing 150,000 tons

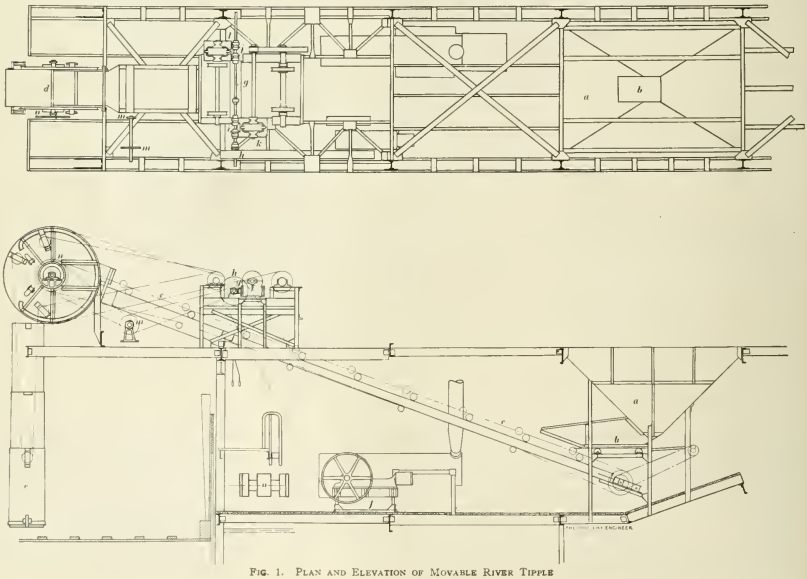


Fig. 1. Plan and Elevation of Movable River Tipple

or more of coal yearly. Shipments are made both by rail and water. A railroad about 1¼ miles long connects the mine with the river tipple and trains of 18 cars, each car holding 5 tons of coal, are run between the two points. The framework of the DeKoven river tipple is shown in Fig. 6 being placed on temporary foundations prior to its being moved to the permanent foundations and track to the rear, not shown distinctly. The entire framework and head-house covering the machinery is shown in Figs. 4 and 5, also the plane on which the tipple is moved up or down to conform with the height of water in the river. At these river tipples, boxes, flats, coal boats, and barges are loaded. Barges that will hold about 600 tons of coal or more are shown at both tipples. They are constructed of 6-inch timbers and are staunch. Coal boats are constructed of 2-inch and 3-inch planks and will hold about twice as much as a barge, being 50 feet wide and longer. To prevent coal boats having their bottoms loosened, the coal must be laid in the bottom and not dropped from any considerable height. The ordinary river tipple shown in Fig. 3, which, however, in this case is an extraordinarily good tipple of its kind, makes use of chutes to load baskets which are then lowered within a few feet of the top of the boat and discharged. These baskets are weight-balanced so that on being loaded they raise a weight and are lowered, and on being discharged they are brought up to a position under the chute for another load, by the weight descending.

The railroad cars shown back from the tipple bring coal from Sturgis and other mines of the Western Kentucky Coal Co., and are dumped in the hoppers below the tipple floor and above the loading basket. Over 1,000 tons of coal can be loaded from this tipple and although the baskets hold a little less than 2 tons, they may be worked quickly. At the DeKoven tipple the cars coming from the mine are run down a short gravity plane. The loaded car in descending hauls an empty car up the plane. The descending cars run to the covered part of the tipple nearest the shore and being bottom dumpers they are discharged directly into a hopper which feeds a traveling belt, the framework of which is shown in Fig. 6. The belt raises the coal to the level of the tipple platform and discharges to a loading boom that deposits the coal gently in the bottom of the boat.

Engine, boiler, and steam winches for hoisting the tipple up the plane, warping the boats into position and moving the loading machinery, are all under cover on this self-contained movable river tipple. Bartlett-Snow Co., of Cleveland, Ohio, constructed this tipple and worked out the details. The tipple was not considered much of an affair because of its diminutive size, however, it is now tuned and can load more coal than the mine can supply or 270 tons per hour, a rate that will compare favorably with any river tipple so far built.

Through the courtesy of the Bartlett-Snow Co., who are the manufacturers, a plan and elevation

Fig. 2. Caseyville after the Flood

Fig. 3. Western Kentucky Coal Co.'s Tipple

Fig. 4. DeKoven River Tipple

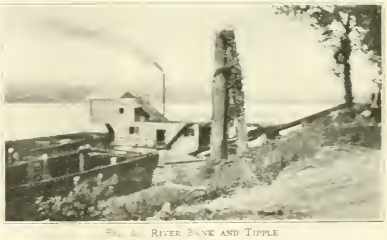


Fig. 5. River Bank and Tipple

of the tipple, as shown in Fig. 1, are supplied. The coal falls from the cars into the hopper *a* and is fed by the plate feeder *b* on to the 30-inch belt conveyer *c*, that travels at a speed of 318 feet per minute. The belt delivers from the head pulley *d* to the loading chute *e*.

The method that is adopted for driving the conveyer belt, and

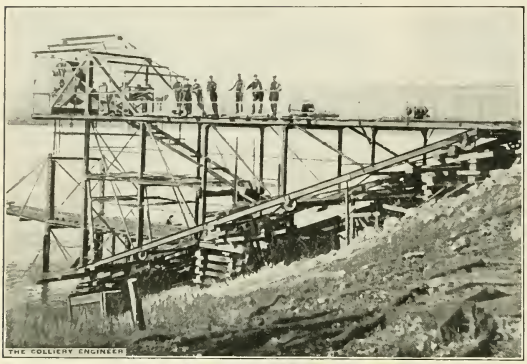


Fig. 6. Framework of River Tipple at DeKoven

for raising the loading chute as well as the tipple itself, is as follows:

The 20-horsepower Erie engine *f* drives a line shaft *g* on which is a 28-inch diameter pulley *h* and beveled gear-wheels *i* and *j* by means of an 8-inch belt. The gear-wheels *i* drive the worm-gear *k* which by means of cog wheels raises and lowers the tipple on the incline. The gear-wheels *j* drive the worm-gear *l*, which, by means of a drum 18 inches in diameter and wire ropes, raises and lowers the loading boom *e*. A sprocket wheel attached to shaft *g* drives the sprockets *m* and *n* by means of a roller chain, and this system drives the conveyer belt *c*. The warping engine *o* has a cylinder 7 inches in diameter and 8-inch stroke. It was made by the Chase Machine Co., and has two drums for ¾-inch wire rope. All the machinery is run by steam from a 20-horsepower Economic boiler.

State Interference in British Mines

By Special Correspondent

A favorite topic with chairmen of British colliery companies when they have to face shareholders at annual meetings is "State Interference." A chairman of a Durham company raising nearly 2¼ million tons of coal per annum, pointed out that the companies were constantly having further impositions put upon them by legislation and local rates. It was difficult to gauge the effect of the Eight Hours Act, but it was probably about 3d. per ton and that was without taking into account the capital and special expenditure they had to incur to minimize the loss; and also in some cases they had had to concentrate on their thicker seams, much reducing their present cost at the expense of the future. Perhaps the truest indication of the Eight Hours Day, although it might be modified by other acts, was to compare the quantity of coal raised under its working with what formerly prevailed. For the year ending December 31, 1909, 320 tons was raised per person employed, but during the following year the quantity was 279 tons—a reduction of 41 tons. This was equivalent to an increase of 15 per cent. in labor, but against that there must be set the fact that operators had not been able to work their collieries so many days, owing to the state of trade, and there had been small stoppages. Fortunately, some operators were in a position of owning shallow collieries which they could stop without excessive cost. Whilst reluctant to do so, both on account of the suffering to the men and the disorganization of their arrangements generally, if prices remained as at present there was no doubt they would have to shut down some of their pits in the near future, which were the most expensive to work. They were faced with the extra cost occasioned by the Eight Hours Act, the increase of compensation, which meant in all their collieries over a penny per ton; and then, with the Mines Bill which was passed he dreaded to think of what would happen. He has had a detailed estimate made of what the Mines Bill as it was originally introduced would cost his firm and it worked out at £151,000. In addition to that there would be the continual additional cost in the working of collieries. He did not want to say anything which would interfere with the negotiations going on, but he hoped some of the provisions of the code might be largely modified. The question of interference by the government and government departments he strongly protested against, and it seemed to be thought by some of the workmen that the more officials there were appointed and the more inspectors and returns made, the better it would be for the workmen, whereas it was not so, as the bills of the cost must eventually come out of their wages. The total wages and salaries paid during the year amounted to 66 per cent. of the selling price of the minerals, so that there was only 30 per cent. for royalty, rents, supplies, rates, and taxes, and many other charges, not to mention depreciation and profit.

At the request of West Virginia operators, the state mine inspectors have been going over the mines in some districts, four times each month.

American Coal-Dust Precautions

Methods of Preventing Coal-Dust Explosions, From the American View Point

By George S. Rice*

DESPITE the fact that for the past 30 years many of the leading men in the coal mining profession in the United States have believed that the tremendous extension of explosions in bituminous mines was chiefly due to coal dust, this idea did not find general acceptance among either miners or operators until recent years.

Most mining men thought that there must have been firedamp present where mine explosions had occurred, hence the great effort on the part of operators was to prevent accumulations of gas by thorough ventilation of the workings; and when this was done they felt reasonably safe from disastrous explosions.

Even those who believed that coal dust would ignite directly from a blown-out shot or the firing of a small pocket of gas, did little or nothing which would prevent the propagation of an explosion once started, but concentrated their efforts on preventing the ignition from occurring. While no one will gainsay that "an ounce of prevention is worth a pound of cure" yet today this is not considered enough.

Greater care in ventilating and in blasting are very practical methods of preventing explosions, but sometimes by a combination of circumstances or through carelessness of an individual, local ignitions of gas or coal dust will occur, hence the necessity of prevention of propagation of an explosion throughout the mine.

Possibly the mining men in the Middle West were first convinced of the danger from coal dust alone, because in the shallow mines of Iowa, Missouri, and Kansas particularly, firedamp was rarely, if ever, met, yet explosions occurred now and then during the firing of shots, although the dusts in the mines of these states are not highly inflammable in comparison with the dusts found in the Appalachian coal mines. The low inflammability of the dusts is indicated by their composition, and is further evidenced by the fact that the explosions which have occurred are often limited in extent, only one portion of a mine being affected; or the explosion would merely run from the point of ignition to the mine opening. It was generally agreed by the mining men in the Middle West districts that such explosions were explosions of coal dust, though possibly they might have been added to by the smoke from extensive charges of black powder, particularly in "shooting off the solid."

In Iowa it was thought that the conditions were aggravated by a strong ventilating air-current, and this led a State Commission, in 1893, to recommend that the fan be slowed down during shot firing time, and that shot firers be employed to fire the shots when the other employes were out of the mine. As explosions in Iowa still continued, even under these conditions, the method of watering of the roadways was introduced and practiced to some extent; but that it was not always done thoroughly would appear to be the case, since while the number of explosions has greatly lessened, they have occurred occasionally, as evidenced by the recent one in that state, which is said to have wrecked the mine.

Other Middle West states, Kansas, Oklahoma, and Arkansas, followed Iowa's lead in the employment of shot firers to fire the shots when the men were all out of the mine, and also in slowing down or shutting off the fan altogether during the shot firing. The latter constitutes one of the chief methods employed in these states. It is claimed by its advocates that not only is less dust stirred up during the shot firing when there is no moving current of air, but that the lessened volume of the air-current, or the quiet air when the ventilation is suspended, is vitiated by blackdamp, which lessens the amount of oxygen present, and thus reduces the chances of an explosion. The almost monthly occurrence of explosions in the Southwest, where the method is practiced, originating from reckless shooting with dynamite or black powder, does not argue strongly in favor of the efficiency of this system of shutting down the fan.

If there is any merit in this system of preventing explosions, it is only one of slight degree, since far more explosions occur in the Southwest than in any other coal mining district of the country; although fortunately, the number of deaths from these many explosions is limited, owing to there being no one in the mines but the shot firers. It must also be pointed out that in mines producing any inflammable gas there is a probability of increasing the danger of ignition.

In Indiana and Illinois, owing to the more general practice of undercutting, or, in certain districts, of shearing the coal, the number of explosions did not become alarming until after the adoption, in 1897, of the plan of paying the miners on the run-of-mine basis, instead of the lump-coal basis. This led to an increase in the use of explosives, as the miners were not penalized by reason of breaking up the coal as they formerly had been under the lump-coal basis; it also led to greater extension of the method of "shooting off the solid." The explosions which followed caused the adoption of the method of employing men to inspect the shots, and at the end of the day's shift to fire them when the men were out of the mine; but in these states the plan of shutting down the fan was not tried.

*Chief Mining Engineer, United States Bureau of Mines.

In Illinois there was a marked improvement, due to the more or less complete inspection of the holes prior to shooting; but in Indiana, where large drill holes and excessive charges of powder were permitted (the state laws allowing 7 pounds per shot, and in some instances it is reported that nearly a keg of powder has been used in a single shot) the conditions have not materially improved, so that explosions are still being experienced. Formerly in the western coal fields some watering was done along the principal roadways, by means of water cars, and in a few mines exhaust steam jets were employed at shot firing times; but it cannot be said that systematic watering or humidifying was practiced in any of the mines until recent years, with the exception of the coal mines of Utah.

In that state, following the explosion disaster at Winter Quarters, May 1, 1900, in which nearly 200 men were lost, the state passed laws requiring complete watering of the mine by washing down the working places with hose. Since that has been done there have been no explosions in Utah; which, while not conclusive, is strongly indicative of the success of the method.

In the great Appalachian coal field, from which comes the bulk of the coal output of the country, the ignition of coal dust by blown-out, or overcharged, shots has been comparatively much more rare, as undercutting of the coal is generally practiced, and only moderate charges of explosive permitted. It was believed the most important precaution was to obtain good ventilation, and it was felt that if the firedamp was not ignited there was little chance of there being an ignition of coal dust. The rapid increase in the production of coal from individual mines, which had begun in this country in the Appalachian field, led to great increase in the velocity and volume of the ventilating current, in order to supply the necessary amount of air for the larger number of employes underground, and also to dilute and sweep out the firedamp. Unquestionably this increase in the ventilating current increased the tendency to dry up coal dust along the roadways, in the winter months; also through the practice of building up the coal above the sides of the cars, when the rapidly moving electric locomotives were introduced there was a greater production of dust along the haulageways, through the grinding up of the fallen coal, and through the dust being blown off the cars by the air-currents. Undoubtedly, therefore, the hazard from coal-dust explosions was constantly increasing during the decade prior to 1907. The number of men lost through explosions began to increase, and finally culminated in a series of disasters in Pennsylvania, West Virginia, and Alabama in 1907. This woke up the mining men in the eastern fields to the realization that something must be done to prevent the increase of such disasters. Accordingly one of the outgrowths of the situation was that Federal investigations of coal-dust explosions were begun in 1908.

Introduction of Permissible Explosives.—It was fully agreed that one of the greatest causes of explosions in this country was through the use of explosives. To overcome this, there had been an effort made to introduce so-called "safety explosives" similar to those already being used in Germany, but little progress was made in this direction, and most of these earlier explosives proved neither efficient nor safe, until the government began systematic testing of mine explosives at the Pittsburg station, and established certain requirements which the explosives must meet through tests in the presence of gas and dust; that is, that within certain charge limits they must not ignite gas or dust. The manufacturers responded well, and a large number of explosives were developed which passed the tests, and were placed on a list of permissible explosives for use in gaseous and dusty mines.

Permissible explosives are now being used in almost all admittedly gaseous mines, particularly in Pennsylvania, Alabama, and Colorado; but the great bulk of the coal of the country is still being shot down by black powder, and in certain fields dynamite is also used, but generally not by permission of the mine managements, or state inspection departments; hence the larger number of the mines of the country are still exposed to the risk of ignition of dust or gas by long-flame explosives.

Other Causes of Explosions Than Explosives.—In the Middle West and Southwest undoubtedly the majority of the explosions are still caused by the misuse of explosives; but in the more gaseous fields, as the Appalachian and Rocky Mountain coal fields, there have been other causes of explosions, which while fewer in number have been more startling because of the larger number of men that have been killed in them. Some of these were caused by ignition of pockets of gas by open lamps, or by the short-circuiting or arcing of electric lines, particularly by the open trolley wire. The latter is thought to have been the cause of a number of the greatest explosion disasters, and in most of them it is thought gas has not been involved, the dust being brought into suspension by a fall of roof, or wreckage of cars, which has also caused at the same moment a short-circuiting of the trolley or other electric wires. It is obvious that ignitions of coal dust by prior ignition of pockets of gas would largely be prevented by the introduction of safety lamps, either oil or electric; but even then there is a possibility of ignition of gas occurring through a defective safety lamp, or other more remote cause; hence the necessity of introducing means of preventing propagation of the explosion through the agency of coal dust. The problem of the electric wires, and more particularly the trolley wire, is more serious to overcome. Electricity employed for pumping, undercutting, and electric haulage, is so generally introduced in the mines, that it would be commercially impossible to bar it out, as it is of such great economic value.

As falls of roof may occur at any time, with consequent short-circuiting, it is obvious that coal dust must be rendered inert to prevent general explosions.

METHODS OF PREVENTING COAL-DUST EXPLOSION PROPAGATION

Watering by Tank Cars.—A system of simply watering the roadways has been in use both in this country and abroad; but it has usually been confined to watering along the principal roadways, and, as already commented, this has not always been systematically done. The method often consisted in merely pulling out a plug in the bottom of the tank of the water car, and letting the water dribble as the tank car is pulled along, thus wetting only between the rails. It is needless to say, in the light of present information, that this method is of very little value, and it is regretable to say it is still employed in a considerable number of mines in the country. There have been developed excellent types of tank cars which employ pumps geared to the wheels, so that as the car moves water may be forced out under pressure to wet down the roof and ribs, as well as the whole floor of the passageway. These are being used in some of the largest mines of the Pittsburg district, also in some West Virginia mines. Here, again, limitations are found, in that the watering usually is done only at irregular intervals so that the coal dust has dried out between waterings; and when coal dust is dry it is extremely difficult to wet. A thick coating of coal dust has been observed resting on the surface of water for months without becoming wet. The method of watering by tank cars has usually been confined to the main entry ways, and has seldom been applied in the rooms. While in some mines where the dust has a naturally high moisture and ash content this may be sufficient, but where the dust is very inflammable it is not.

Watering by Hose.—The system of daily watering by hose, which has been a requirement for many years in Germany in dusty mines, has been used to a considerable extent not only in Utah mines, but also in other mines of this country, particularly within the last year or two. In a number of the large mines of Pennsylvania, West Virginia, and the Southern Appalachian states, as well as in the Rocky Mountain districts, watering lines have been laid throughout the mine, and hose men are constantly employed in going from point to point watering the dust. However, in many mines watering the roof and sides has been avoided, as it is considered by the mine managements that the roof would be injured, and that the danger of numerous accidents from falls of roof would greatly outweigh the danger of accidents from explosions. In a considerable percentage of mines, it is believed by the author that the roof would not be materially injured by watering, and it has been noted that there is an increasing tendency on the part of mine managements to require the sprinkling of the roof and timbers. In mines in which there is extensive use of collars and lagging, there is particular danger of coal dust collecting. The author has gathered dangerous quantities of dry, inflammable dust on timbers over places where water covered the floor to the tops of the ties. The use of hose has great merit in that the cleaning can be done very thoroughly by using water at high pressure, and if continued daily and systematically the dust will remain wet. When the roof is of a character that it would be seriously injured by watering, rock dust or flue dust should be placed on the timbers and ledges.

Fixed Sprinklers.—Fixed sprinklers have been installed in a number of mines through the country, but in certain large mines they did not prove effective in preventing disastrous explosions. It has been observed that the range of wetting is very limited. In one mine it was recently noted that dry dust was found on timbers on the return side of the sprinkler, within 10 feet of same. The trouble appears to be that the sprinklers are often not in condition, become easily clogged, and the water being discharged in large drops is not taken up by the air-currents, and falls to the ground in the vicinity of the sprinkler and drains away. Undoubtedly, fixed sprinklers could be used to advantage on partings or sidings, to wet down the dust on the tops of cars. Strong water jets near junctions or sidings are employed in some mines of South Wales for this purpose, which are automatically turned on as each loaded car passes.

It has been noted in examining mines in which fixed sprinklers are used that the haulage men and others working along the roadways, disliking to get wet, are apt to either turn off the sprinklers, or else divert the spray to one side so that it has little effect.

Fixed sprinklers, employing compressed air, in which the water is broken up into very fine atoms, or sprinklers which by centrifugal force and mechanical obstructions the water is turned into the finest spray, may be more satisfactory, but it has not been observed that such sprinklers have as yet been introduced in American mines except in a limited, experimental way.

Calcium Chloride.—In some mines of Pennsylvania and West Virginia calcium chloride has been used to a considerable extent to keep the dust in the goaves moist, and also to better retain moisture in the roadways. In very few of the mines can it be said that calcium chloride has been systematically used. In a number of instances the so-called "calcium chloride" has been practically nothing but common salt, and this has very little virtue.

It is believed in special cases there is a considerable opportunity for the employment of calcium chloride, particularly when in granular form. It is pretty generally understood, as a result of experiments, that if the coal dust can be matted together so that it will not be brought up into suspension by a shock wave, that the danger of propagation of an explosion is greatly diminished.

Humidifying.—Some of the operations, in Pennsylvania and West Virginia particularly, have inaugurated systems of exhaust steam jets in the intake to humidify the mine air, which serves two purposes: one to prevent the extraction of moisture from the mine by what would otherwise be a drying current; second, to employ the method of humidifying as a means of carrying water into the mine to deposit same on the dust. Extensive experiments in this direction were carried on in 1908 by Mr. Frank Haas, of the Fairmont Coal Co., following the Monongah disaster; and the method was found to be so successful under the conditions that prevailed in the Monongah mines of that company, that the system was applied in all their mines in West Virginia and Pennsylvania. The method has been strongly advocated by others, and there are a considerable number of installations in the Southern Appalachian field, as well as in West Virginia and Pennsylvania. It is used in a few mines in Illinois, also in some mines in the Southwest, but it cannot be claimed that there are very many mines in the Western Districts where it has been systematically carried out.

There has been a good deal of misapprehension about the employment of steam jets, and many have thought that if the air in the working places is kept in or near a saturated state that that was sufficient, but this is not the case. The air-current takes up the moisture so rapidly that the return air is nearly always saturated. The important feature is to keep the intaking air not only saturated but supersaturated; in other words, fogging the air with condensed steam, so that it may be deposited further on in the mine. Necessarily varying quantities of steam are needed to accomplish this purpose, so that if merely a constant stream of exhaust steam is blown in, while there may be enough in mild weather, this same amount will not be nearly enough in cold weather.

Fogging the intake makes it difficult to apply the system except by placing the haulage roads on the returns; however, unless the mine is very gaseous this does not seem to be seriously objectionable. At a few mines this difficulty has been overcome to a certain extent, by preheating the air, but this is a somewhat expensive method, and has not come into very extensive use.

Many operators have felt that saturating the air, producing such a generally moist condition, would damage the roof when it is a soft shale. However, others have contended that there is much less danger of the roof being injured than through natural agencies, that is, the changes of seasons producing an alternation of wetting and drying, whereas when steam humidifying is done a uniform condition prevails. Some have also thought that steam would heat the air seriously; this, however, is true only to a very limited and local extent. The increase in temperature due to introducing steam in the intake, except near the jets, is slight and it is not at all uncomfortable to approach to within a few feet of the steam jets. The reasons for this are that there is introduced into the air-current only a small weight of steam as compared with the weight of air, and as some of the steam has already condensed into water, on issuing from the jets, the reevaporation of this has a cooling effect. The net result, under ordinary conditions of cold weather, is to increase the temperature of the ventilating current at a cross-section near the jets, not over 10° or 12° F., which generally does not bring the temperature of the current up to that of the mine walls.

Usually where a simple engine is employed to drive a fan it produces enough steam to humidify the air in moderately cold weather, and it is only necessary to supplement with live steam during the coldest weather.

The method of wetting the coal dust by exhaust steam jets was put to a magnificent test a few years ago in two adjoining mines of the Fairmont Coal Co. (now part of the Consolidation Coal Co.). Natural gas under high pressure leaked from a well into the two mines which were separated by a barrier pillar, causing a local explosion in each, but the coal dust had been so dampened down by the steam humidifying method that it was not ignited by the gas explosion.*

It would not appear from inspection and reports received from various coal districts of the country, that any considerable percentage of the total number of mines have adopted the method. It is unquestionably one of the cheapest methods of dampening the dust where there is exhaust steam available, and it is more or less automatic, which is of great importance. The method has not been sufficiently tried out in all parts of the country to be able to state positively that it can be applied universally with success in wetting the coal dust, but its use would at least prevent the mines from being dried out, so that supplementary wetting by sprinkling or washing down with hose, would keep the mines in good condition.

Rock-Dust Treatment.—The method of counteracting the coal-dust danger by treatment with rock dusting has awakened a great deal of attention in this country through reports of the successful experiments at Altofts and Liévin, and more recently at the government experimental mine at Bruceton, Pa. While in France the method is officially approved, and is now being extensively employed, in England, in spite of the favorable reports of the Altofts and Eskmeals tests, it does not appear to have been generally accepted, although it is employed in a number of mines, and is apparently being favorably considered by a large number of mine managements.

One of the objections that has been raised to it, is that it would be dangerous to the health of the employes through causing phthisis, or

*Described by C. H. Tarleton, before the West Virginia Mining Institute in 1911.

miners' consumption. It therefore becomes very necessary to employ dust which will not be siliceous, or at least is not composed of sharp, flinty grains. It would be better to have a dust which will be absorbed and ultimately discharged by the bodily functions and not accumulate in the lungs, as does quartz dust.

Adobe-Dust Treatment in Delagua Mine.—So far as reported, only one mine in this country has employed the rock-dust treatment, i. e., the Delagua mine, in Colorado, where adobe dust gathered on the surface has been used in portions of the mine. The method of dust treatment employed at this mine has been fully described in technical papers and in previous issues of The Colliery Engineer. Briefly it is the application of adobe dust to the ribs and floors along the trolley haulage by means of a blower mounted on a car, further supplemented by cross-shelves and side shelves, on which dust is placed, after the Altofts system.

Conclusions Drawn from Tests of Rock-Dust Treatment at the Bruceton Experimental Mine

It is undoubtedly better to prevent an explosion from starting than to try to arrest it after it is well started. This has been demonstrated by tests at the Bruceton experimental mine, where it has been found that mixture of fine coal dust and rock dust in equal proportions will not ignite with an ordinary blown-out shot; yet if there is a strong preliminary explosion of pure coal dust the explosion will propagate with violence throughout a zone containing such a mixture; and it is not until the ash and moisture content reaches 75 or 80 per cent. that propagation has failed in the tests so far made. Incidentally, one important point has been found out which has a bearing on watering methods, i. e., that if shale dust is intimately mixed with coal dust, the mixture no longer resists water but quickly takes up water and sticks together. This suggests that in some cases a combination of moistening and rock-dust treatment would be of great value. It would doubtless be of special value with coals of a friable nature, and points to the advisability of sprinkling the walls with a muddy water, so that the fine particles of coal would not flake off, but would be covered by a muddy coating. Finely ground limestone makes an admirable dust for this purpose since it whitens the passageway like whitewash, making the miners' lights more effective, and moreover the presence of coal dust is made more readily observable.

Experiments with shale and with limestone dust have been made at the government's experimental mine, at Bruceton, both in zonal treatment, and in arresting barriers, and so far as tests have gone up to date, has been found effective in preventing the propagation of dust explosions. Shale-dust treatment will require the establishment of small grinding plants, but finely ground limestone can be purchased in the Pittsburg district for $3 per ton f. o. b. cars, put up in paper sacks. Doubtless in bulk the price would be considerably cheaper, as limestone dust is a waste product in many parts of the country.

Application of Rock Dust in a Mine. After a roadway has been cleaned out of coal dust as well as can be, the shale or limestone dust is then strewn on same, and thrown on the ribs and roof, to which it adheres very readily. Let us suppose that the first application of rock dust in a roadway, cleaned as well as can be by scraping and shoveling, is at the rate of about 4 pounds per linear foot of roadway, then 1 ton would cover 500 feet of roadway, and about 10 tons would cover 1 mile of roadway; in a mine having 5 miles of roadway it would require about 50 tons. If the freight and handling at the mine amounted, say, to $2 per ton, and the application within the mine does not exceed $1 per ton, this would make a total cost of $6 per ton applied, or $300 for the whole application to 5 miles of roadway. From the experience in some of the English mines, the roadways do not have to be dusted on an average of more than two or three times a year; but as coal dust is produced more freely in the mines of the United States, let us suppose that it has to be applied four times a year, this would give a total cost of $1,200 per annum for 5 miles of roadway. A mine with this total length of live roadway might produce 120,000 tons of coal; the cost of dust treatment would then be 1 cent per ton of coal produced. In England figures have been given showing that the cost at certain mines is much less; it is therefore likely that 1 per cent. per ton is an extreme figure in mines where the dribbling of coal from cars is small, as in treatments subsequent to the first it is probable that less rock dust would be required than in the first application. However, many operators are paying nearly as much as this for watering, and if the watering is thoroughly well done, it is probable that the cost would be as large. One of the greatest merits of the general rock dusting treatment throughout the mine is that it is visible, and the condition does not materially change from day to day, as in the case of watering.

Regarding the effect of shale dust free from silica (flue dust or limestone dust) on health of underground employes, it is believed that such dusts would not be injurious. Altogether the rock-dust treatment system appears to have a great deal of merit, and it is hoped that it will be put to more extensive tests under American mining conditions.

Rock Dust Arresting Barriers. While the Taffanel system of arresting barriers has proven very effectual in limiting explosions under experimental conditions, some have thought that it was not applicable to the conditions of the mines in this country, since high velocity air-currents, and the currents of air produced by rapidly moving trips of mine cars, would tend to blow the dust from the shelves; further, any watering system might wet the rock dust and neutralize its efficiency.

Certain new forms of rock-dust barriers have been developed as a result of the Bruceton experiments to meet these conditions. Two general types have been experimentally successful; one consisting of a group of four or more individual boxes, containing about 400 pounds of rock or other inert dust, suspended by hooks from the roof or timbers in such a way that a strong blast of air will release the rods on either one side or the other according to which direction the explosion has advanced from, causing the rock dust to be discharged into the air so as to make a dust cloud that will smother the flame of the explosion. The other type of barrier, termed a "concentrated barrier" consists of an overhead double-hinged platform, held up by levers; these levers are set in operation by swinging vanes, which may be placed at considerable distances apart, 50 or 100 feet, so that an advancing explosion will cause the hinged platforms to partially drop, the full drop being arrested by chains, the dust being discharged in clouds. One form of concentrated barrier consists of boards hinged separately, the other end of which is held up by chains of different lengths, so that the rock dust may sift out more gradually; and also in case of an accidental tripping of the levers, will not seriously injure a man passing underneath. When an explosion is very violent the whole barrier is torn to fragments, throwing the entire mass of dust into the air, thus extinguishing the flame. In a light explosion, the rock dust sifting out from between the displaced boards, smothers the flame. The barriers have so far resisted the passage of an explosion, several of which have been quite violent.

The special merit of the foregoing devices, as compared with the original form of the simpler Taffanel shelf barrier, consists in the rock dust being retained in comparatively tight receptacles, so that supplementing means of watering or humidifying may be used without danger of moistening the dust; also the rock dust will not be blown away by the air-current.

In the case of the concentrated barrier, the rock dust is loaded so that it extends up to the roof, the space occupied being about 18 inches from the lagging or roof to the bottom of the box. Of course, in thin coal beds it may be necessary to brush down some of the roof to provide a place for the barrier.

The box barriers also occupy about the same space. When they are used in mines where humidifying or watering systems are employed, they may be covered with a waterproof cloth, attached to the roof so that as one side of the box falls, the covering is held to the roof so as not to interfere with the release of the dust cloud.

Similar confined rock-dust containers are being arranged for use in connection with ventilating doors and overcasts, as usually it is very vital to arrest explosions at such points. The application of some of these devices to stoppings in crosscuts and breakthroughs is also being experimented with.*

Weathering of Pittsburg Coal

The results of investigations into the weathering of the Pittsburg coal bed at the Experimental Mine, near Bruceton, are detailed in Bureau of Mines Technical Paper No. 35.

The authors, Horace C. Porter and A. C. Fieldner, have verified the well-known fact that indications of weathering such as yellowish coating of iron hydrate or a dull appearance of the surfaces, do not always signify a material change of the chemical composition or heating value of the coal itself.

The chemical analyses show that changes in composition have occurred in the coal for a distance of about 50 feet from the outcrop. The analytical data serve as a basis for certain deductions as to the nature of these changes. Certain dissimilar properties between Pittsburg weathered coal and the Cretaceous coals and lignites render it altogether doubtful whether a reversion of bituminous coal to lignite could ever take place through the agency of weathering. The analyses also show that the composition and heating value of the unweathered coal, computed on the moisture and ash free basis, are fairly constant.

Special tests were made to show the relative oxygen consuming power of the coal samples and their power of liberating inflammable gases, because these properties are known to vary with the nature of the coal. As the direct union of freshly broken coal with oxygen lowers the oxygen content of mine air in places where ventilation is inadequate, and as the continuous escape of inflammable gas from broken coal tends to increase the danger of explosions, it is of interest to determine to what extent this behavior of coal is affected by proximity to the outcrop and consequent weathering.

Samples were taken at different points in the mine and put in 5-gallon glass bottles, the coal being crushed so as to pass a ½-inch screen; 20 pounds were placed in each bottle as quickly as possible after the coal had been broken down and the bottle was sealed before it left the mine. By admitting air to the bottles in measured quantities daily and drawing off the air and gases the progress of oxidation of the coal and of the liberation of inflammable gas was followed.

Utah's Lofty Mountains

Utah has six mountain peaks which rise more than 13,000 feet above sea level. The highest is Kings Peak, with an elevation of 13,498 feet, but Mount Emmons and Gilbert Peak are also lofty mountains, 13,428 and 13,422 feet, respectively. The other peaks rising above 13,000 feet are Mount Lovenia, 13,250 feet; Tokewanna Peak, 13,200 feet; and Wilson Peak, 13,095 feet.

*Applications for patents covering the above devices have been made by the author of this paper, on behalf of the Bureau of Mines, for the free use of the public.

Coal Loading Methods

At United States Ports—Modern Coal Piers at Newport News, Baltimore, Philadelphia, and New York

By J. F. Springer

With the opening of the Panama canal, the United States may expect an increase in the coal sales made to foreign buyers. Ships making the passage through the canal will need to lay in a bunker supply either on the Isthmus or at some convenient port not too far distant. It is probable that in many cases the route to the canal will be selected according to the price of coal in American ports and the facilities for loading the ships.

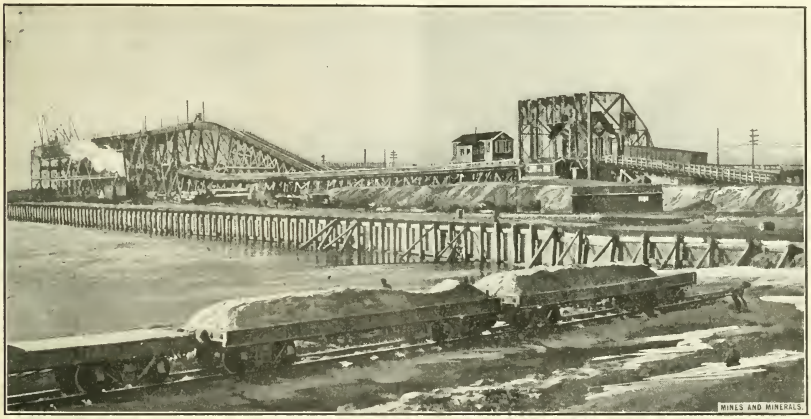


Fig. 1. Coal Pier of Virginian Railway, Sewalls Point

When the Panama canal is thrown open to ships, there will be with the Suez canal a reasonable round-the-world all-sea route in existence. This may not be employed as a whole by many of the steamship lines for some time to come; but at once there will be portions of the entire circuit employed together with certain deviations. From a very considerable number of ports in the eastern part of the Old World, it will be a matter of indifference, in so far as distance is concerned, whether a ship bound for New York or Liverpool sails east through the American canal or west through the Suez canal. Thus, the distance from Hong Kong to New York is about the same whether the route followed goes through the one canal or the other. From Wellington, New Zealand, to Liverpool, the route via the Panama canal is about the same length as that via the Suez canal. In many such cases, the cost and ease of obtaining coal will probably become an important consideration in reaching a final decision.

The government proposes to supply coal on the Isthmus of Panama; but the price of this coal will have to include transportation from some of our eastern ports. It is not at all clear that ships passing through the canal going to or from European ports will find any advantage in coaling at the Isthmus rather than at one of our ports on the Atlantic coast.

Undoubtedly, the natural point for such coaling will be Hampton Roads, the entrance to Norfolk harbor. Here are terminals of the Chesapeake & Ohio, the Norfolk & Western, and the Virginian railroads, which bring coal from the Celebrated New River and Pocahontas fields of West Virginia. This harbor is easily accessible from the ocean; so that geographically, it is a suitable point at which to stop. Baltimore, Philadelphia, and New York harbors are also bituminous coaling stations of importance; but they seem either too far north or are too far inland from the sea. In short, Hampton Roads is advantageously situated, the quality of the coal is right, the supply is adequate, and as price is right, it remains to consider its facilities for the loading of vessels.

Hampton Roads has grown to be a great distributing point for steam coal quite apart from the considerations growing out of the Panama canal; and from this point coal is shipped north by water, is exported to foreign countries; and a large quantity sold to the United States

Navy. It contains three ports: Newport News, Lamberts Point, and Sewalls Point. Eight piers are operated at these ports and unload coal into vessels at the rate of about 2,000 carloads per day. The facilities while at present more than equal to this business, are in course of considerable extension. At Newport

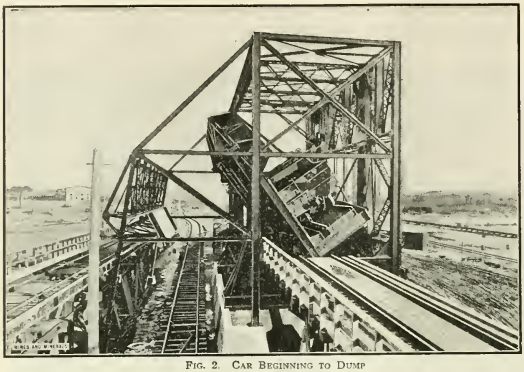


Fig. 2. Car Beginning to Dump

News and at Lamberts Point, the C. & O. and the N. & W. are building two piers, either of which will have a capacity of 600 carloads per day. These piers will rank among the greatest in the world. They will certainly be much the largest on the Atlantic coast of the United States.

Both of these piers extend from the shore a distance of 1,200 feet, and are accessible from the two sides. Both have an elevation above the water of 90 feet. The Virginian Railway has a notable pier at Sewalls Point, although it falls somewhat short of these two under construction. Its height is 69 feet and the mode of operating it is similar to that which will be employed at the new piers.

Where large ships are to be loaded, the height of the pier is a most important matter. The coal slides from the cars into a pocket or bin from which it is chuted outward and downward to the open hatchway. This means that considerable fall must be provided between the deck of the pier and the top of the hatch. The two principal variables to be taken into account are the tide fluctuations and the height of the hatchways above the water, as these change with the vessels and the load. Taking these factors into consideration, the vertical distance between pier deck and ship hatchway should be from 33 to 43 feet. The reason there is still a range is that some choice is possible in respect to the depth of the receptacle, whether pocket or bin, into which the coal is discharged from the car. The hatch of a big collier may be 40 or 45 feet above the water. It will be gathered from a consideration of these data why pier deck levels of from 70 to 90 feet above the water have been adopted. One pier already in service at Norfolk has a height at its sea end of 70 feet. New York is at present delivering to vessels a good deal more bituminous coal than Hampton Roads, but New York is not equipped to load a big ship directly from the pier.

The deck to the great pier which the N. & W. R. R. is constructing at Lamberts Point, is a level stretch 1,200 feet in length on which no railway cars will be operated, but instead special dock cars, having a capacity of over 100 tons which will be moved toward the sea by their own power. Little or no power is to be employed in returning these cars to the ordinary levels when empty, as gravitation will be adopted for the purpose. The dock cars will be brought to the pier deck by an elevator operating in a vertical well. The ordinary railway car does not have a capacity sufficient; so the N. & W. has been building and putting into service a big road car whose capacity is about equal to that of the cars used on the pier. These big steel cars have six wheels to a truck and are to be regarded as typical of the most modern developments in the transportation and handling of steam coal.

In order to get the coal from the railroad car to ship's hold, it is taken up a sharp incline, by means of a power operated cable, to the platform of the dumping cradle, where it is held fast and at the same time overturned, the coal being discharged into a dock car standing alongside on a lower level as shown in Figs. 2 and 3. Having received its load, which may be the contents of two railway cars or of one of the new giants, the dock car runs ahead under its own power to the platform of the elevator waiting for it. The elevator then lifts the car to the level of the pier deck, 90 feet above the water. The car under its own power next goes out on the pier until the point is reached where it is desired to discharge the coal. Having discharged its load, the car is shifted to a steep incline down which it is brought under control to about the level of the general surface and then is run to a position alongside the car dumper, when the cycle of movements begins over again. The railway car, after it has been dumped, descends a sharp incline on the end of the dumper opposite to that on which it entered. It runs forward a little and up another short incline, and is back switched on another track into the yard. After the empty car leaves the dumper, no power is employed until it is to be moved out of the yard for its return to the mines. Electric power is used to take the road car up to the cradle;

to operate the dumper, work the elevator and to move the dock car. The method of discharging the coal into boats is shown in Fig. 4, which is the dumper at Perth Amboy, N. J., belonging to the Lehigh Valley Railroad, and in Fig. 5, which is a similar arrangement at South Amboy, belonging to the Pennsylvania Railroad; at these places the coal is discharged into barges for delivery in New York harbor.

What has been said relative to the Lamberts Point pier applies in general to the new C. & O. pier under construction at Newport News. In a broad way, the Virginian Railway pier at Sewalls Point, shown in Fig. 1, is operated along the same lines. The cars are taken up a steep incline by means of a cable to the shore end of the pier which is 7 feet higher than the sea end. The dock cars run down this grade to where the discharge takes place and then are shifted to the gravity return. Gravitation supplies all the power needed for these cars, except at the foot and top of the pier, and brakes furnish their means of control. This pier which is 1,000 feet long is accessible from both sides.

The Lamberts Point docks handled in 1911 a total of 7,376,925 long tons of bituminous coal although their capacity at that time was about 1,980 carloads per day, or 25,000,000 tons per year of 300 days. It is probably impossible for piers loading big boats almost exclusively to operate at full capacity, but the ratio of actual operation to capacity at Norfolk seems to be about the same as at Baltimore and Philadelphia. At New York, the piers operate much more closely to capacity—the ratio of operation to capacity being about 50 per cent. This is probably due to the fact that at New York there is an incessant trade with small boats. In Hampton Roads the C. & O. R. R. handles about 26 per cent. of all the coal loaded from piers; the N. & W. R. R., about 47 per cent.; and the Virginian Railway, about 27 per cent. The C. & O. has at present in service four piers having a total pier frontage (counting both sides) of 4,870 feet; the N. & W. three piers with a total frontage of 5,066 feet; and the Virginian, one pier with a total frontage of 2,000 feet.

Baltimore has two piers of about 60 feet in height at the sea ends. These are operated by the B. & O. R. R. and the Western Maryland Railway, but the Pennsylvania Railroad brings coal into Baltimore for pier delivery. There are eight piers, all of them with the single exception of the Western Maryland Railway pier are operated without the use of power other than that supplied by locomotives and gravity. The methods used at two piers, the one, a B. & O. pier at Curtis Bay and the other a Pennsylvania pier at Clinton Street, Canton, are worthy of note. The loaded cars are pushed by locomotive up an incline to the shore end of the pier, which is higher than the sea end. The cars may then be operated to the pockets or bins under gravity. The empty cars are returned to the yard level by an incline down which they descend by gravity. This is a less modern method of operation than that at Hampton Roads, but it is understood to be economical and flexible. Besides the two Baltimore piers just referred to, six at Norfolk, two at Philadelphia, and four at New York operate in this general manner.

At Philadelphia, the Pennsylvania Railroad is building a new pier which will have a capacity of 300 carloads per day. This pier will be 800 feet long; but will be accessible only on one side. The loaded railway car is brought to the foot of a short incline and by means of a cable it is taken up the steep incline

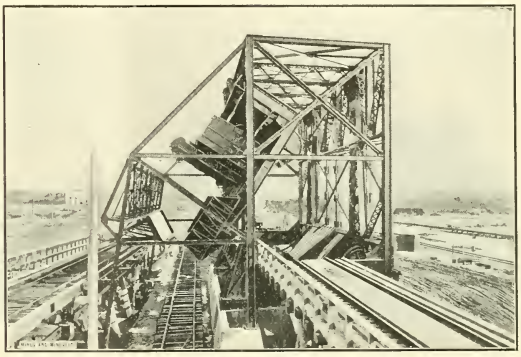


Fig. 3. Finish of Dump

to the cradle dumping apparatus. Here it is emptied into chutes and returned to the ordinary level by gravity. As the action of the chutes depends upon gravitation, it is usual when operating by this mode of procedure to lift the loaded car together with the cradle vertically before dumping. This is done by the same apparatus that performs the overturning of the car as in Fig. 5.

Altogether, Philadelphia has a total daily capacity of 2,340 carloads, without this pier under construction. The Pennsylvania, the B. & O., and the Philadelphia & Reading are the roads which deliver to vessels from piers.

New York harbor has 29 coal piers, mostly scattered over its enormous water front on the New Jersey side, but three are on Staten Island. The daily capacity is 4,350 carloads —2,700 anthracite, and 1,650 bituminous. There is no pier which operates after the manner of the great piers at Hampton Roads, in fact these are the only piers in the Atlantic coal

harbors which do not have one or more representatives at New York. In addition there is a small mechanical plant and two locomotive-operated piers distinct from those at the other harbors. The mechanical plant belongs to the Delaware, Lackawanna & Western Railroad and is at Hoboken, N. J. The coal is discharged into a suitable hopper from which an endless chain conveyer elevates it to bins, from which it is chuted to boats. The adoption of this system seems to have been due to insufficient room to effect a turning of the cars through a sufficient angle to bring them in parallel relation with the pier. The capacity of this plant is 10 carloads of anthracite per day. The pier is accessible from both sides and has an elevation of 5 feet above the level of high water in the Hudson River. There are 18 delivery chutes.

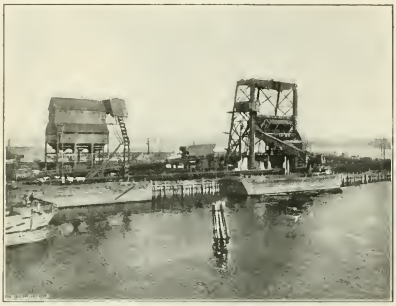


Fig. 4. Plant of Lehigh Valley R.R., Perth Amboy, N. J.

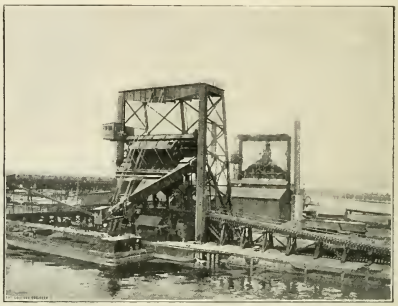


Fig. 5. Plant of Pennsylvania R.R., South Amboy, N. J.

New York's bituminous equipment capacity is considerably less than Norfolk's, however, the New York delivery is, according to figures for 1911, nearly half again as much as Norfolk's.

Into the cost per ton of handling coal many different items enter, but they fall under the two headings: operation and capital invested.

Operation: Under this heading come the items of office and policing, engine service, labor and fuel for machinery, unloading expense and trimming. If locomotives furnish the entire artificial power, there will be no item of labor and fuel for machinery; if elevation to the deck of the pier is secured by elevator or a mechanically operated incline, there will be no locomotive service; and lastly, if the car dumper is employed, the locomotive service and car unloading items will both vanish. The figures reached are as follows, the plan being assumed to operate at 75 per cent. of capacity.

Operating Cost Per Ton

	Type of Pier		
	Locomotive Exclusively	Power Hoist	Car Dumping Apparatus
Office and policing	$.0050	$.0050	$.0050
Engine service	.0051		
Labor and fuel for machinery		.0060	.0098
Unloading cars	.0189	.0189	
Trimming	.0342	.0342	.0308
Totals	$.0632	$.0641	$.0456

These figures show that the operating cost is not much different whether the cars are pushed to the pier decks by locomotives or whether a special cable arrangement is employed. However, where the car dumping machine is used, there appears to be a distinct saving in operation.

Capital investment: In considering the matters of interest, depreciation, and maintenance, the question of the permanency of construction comes into view. Where the future developments cannot be seen with any degree of clearness, temporary construction may be advisable. But this imposes a heavy charge for depreciation and also for maintenance. These are not offset by the increased interest connected with permanent construction, consequently, if the future is reasonably sure, so that there is no appreciable likelihood that the equipment will become obsolete or unnecessary, permanent construction is indicated. Indeed, partly permanent construction is to be preferred to the temporary, but the figures given are for permanent construction. Calling the combination of items under consideration by the name plant expense, the subjoined table exhibits the cost per ton including all matters. The equipment is assumed as operated at 75 per cent. of capacity.

Total Cost Per Ton For Handling

	Type of Pier		
	Locomotive Exclusively	Power Hoist	Car Dumping Apparatus
Plant expense	$.0135	$.0133	$.0128
Operation	.0632	.0641	.0456
Totals	$.0767	$.0774	$.0584

These figures show no great difference between piers operated by a locomotive and by a hoisting device. The decreased plant expense for the hoist is more than offset by the increased cost of operation, so that, unless other considerations have to

be taken into account, the pier operated by a stationary engine would seem to be at some disadvantage. If, however, the question of space enters, it may have a deciding consideration, indeed, may affect the cost per ton, as the figures under consideration are understood to take no account of the cost of land. The price of real estate may accordingly decide the matter. The pier operated with a car dumping apparatus would appear to have a considerable advantage over its rivals. One reason for this advantage lies in the decidedly lower cost for the plant. If real estate questions must enter, then the mechanical method would by all odds seem the best. It may look cheaper for a locomotive or a hoisting engine to push or draw a car up an incline, it should be remembered, however, that the lift has to be made. The smaller the apparatus, the less the cost is likely to be. Where approach tracks are involved or where even the incline of the hoist, the mechanical arrangements become extended. The plant becomes expensive because of its size. At least, this would seem to be a reasonable explanation of the difference in cost per ton for handling.

Handling a Mine Fire

In loading out a mine fire in a colliery in Yorkshire, a certain amount of red-hot coal was met with as the heading went forward, but this was sanded over as soon as it was seen, the method being to throw the heated material and sand on flat iron sheets, where a second man was kept throwing fresh damp sand over it. A third man loaded this into iron cars, and a fourth man padded the surface of the loaded car with yet another layer of sand, before sending it out of the pit. During the whole period of the fire, a good supply of damp sand, as well as a set of patent fire extinguishers, was kept well up to the working place, and the roads leading to, and those around about, the fire, were covered thoroughly with several layers of stone dust.

Efficiency Thoughts in Coal Mining

Items That Enter into Cost of Operation—The Relations that Each Bears to the Others, and How They May Be Controlled

*By Erasmus Haworth**

EFFICIENCY is the science of realizing standards. Efficiency in coal mining requires a set of standards. As an illustration, the standards that were established for a particular coal mine, in a particular locality, are taken, but it is not claimed that these standards would have applied to any other mine.

In the investment of capital there are four general rules, one or the other or all of which are frequently violated:

1. Know the facts and do not be deluded with fancies or guesses.

2. Do not pay more for any property or improvement than you can get back out of it, including 6 per cent. interest, in 8 to 10 years. Do not pay more than $1,000 for a property that will not yield a net profit of $150 to $200 a year.

3. Do not spend $1,000 for an income of $200 until you are sure you have no opportunity to spend $200 or less to save $1,000.

4. Do not allow your capital to shrink. Carry as an operating expense any shrinkage.

Coal properties as an investment are real estate; unless the properties are made productive the interest and taxes accumulate faster than any possible increase in value. A lot in New York at the corner of Broadway and Wall Street sold about 10 years ago for $1,000,000. Even at this price it would not have been a profitable investment in 1800 at $1,000, unless it had brought in current revenue. The great land grants to the railroads would have swamped them if for the first 20 years taxes had been levied at $.10 an acre a year. The taxes would have amounted to $5,000,000 yearly for the Northern Pacific alone.

Coal properties and lumber properties have to be worked. The revenues must come from the coal mined and the trees felled. It is ticklish business in real estate, in coal lands, and in timber tracts to put the certainty of taxes and interest against the guessed at rise in value.

Therefore, in considering timber tracts and coal lands always insist on a separation of land investments from operating investments. The second rule applies to both tract investments and to operating investments.

The third rule is often violated because the first rule about knowing the facts is violated. Do not invest $5,000 to earn $1,000 if you can earn $1,000 by investing $200.

Labor Rules.—It is not what you pay labor, it is the profit it yields that counts. It is a general law applying not only to labor but also to equipment, and to materials that the best grades are relatively cheaper than poor grades. You know that this applies to coal.

The one efficiency rule as to labor is to determine what you can afford to pay and then put in your time and your skill and your energy finding the best men that your permitted pay can buy.

In coal mining you have the mine workers' scale, and under such conditions I have never seen a coal mine in which money was spent to the best advantage for labor.

This is so tremendously important a subject that I wish I could dwell on it, and possibly your descendants 100 years from now will have learned to handle labor in the way you ought to be able to handle it today. A strike seems to me a preventable, ridiculous, stupid thing.

The two rules: "Handle capital economically," "Handle labor economically," are the basis for efficient coal mining.

*Read at a meeting of Coal Mining Institute of America.

To handle capital and labor efficiently is the chief business of the executive. There are many principles, not rules or devices, that will guide him, and without which he cannot succeed. Some great geniuses know the rules instinctively, while ordinary mortals have to learn them.

Some of the principles for efficient direction are: Definite ideals; definite authority and responsibility; constantly available and competent counsel; strict discipline; fair dealing; high and immediate efficiency reward.

The main principles of successful management are that there shall be balance between the three great human incentives: action, appetite, inspiration.

The main principles of successful operation are (1) standardized conditions; (2) standardized operations; (3) advance planning; (4) standards and schedules; (5) despatching of all work; (6) standard practice instructions; (7) records, reliable, immediate, available, classified, and adequate.

Particulars.—A few years ago I was one of a committee which made the following report on a coal mine in a receiver's hands:

If the coal properties were shut down, the annual loss would be $420,000.

If they were operated at the standardized cost per ton of $.857 for an output of 3,000,000 tons and the coal sold at the prevailing price, $.8097, the loss would be $141,900.

The standard cost included a charge for interest of $.067 and for depreciation of $.058, or $.125 per ton.

The standard costs were 14.8 per cent. lower than in the two previous years; and 17.4 per cent. lower than in July and August of the previous year.

This report was analyzed as follows:

1. The coal lands have been injudiciously acquired.

2. Money has been injudiciously spent in equipping the plants.

3. Overhead charges for interest, maintenance, and depreciation are therefore high.

4. The present market selling price for coal is so low as to make profitable coal mining difficult, if not impossible, even if the coal lands had been secured without price, and had been equipped with rigid reference to economical operation.

5. The present situation would be most effectively bettered if the market price of coal increased.

6. To shut down the mines and wait for better prices would entail an annual expense for power, maintenance, supervision, depreciation, and interest of $420,000.

This does not include an annual charge of $104,494 on book value of coal lands not immediately identified with the plans to be operated.

7. The cost of mining coal if operations are standardized, will be $.857 per ton for a daily output of 12,000 tons, a monthly output of 250,000 tons and a yearly output of 3,000,000 tons.

8. The loss from continued operation will depend on the price obtained for coal sold.

If the price per ton is $.66 the loss will amount to $561,000. If $.70 is received the loss will be $420,000. At $.70 per ton the loss from the operations and loss from suspension of operations will be equal. When $.79 is obtained the loss will amount to $200,000. At $.8097, the price netted by coal sales in the two previous years, the loss from operation will be $141,900. If $.857 is obtained there is neither loss nor profit from operation.

If the net returns amount to $.921 per ton, there will be a profit above operation of $192,000, which is sufficient to pay interest on obligations. Coal should therefore continue to be mined. Whenever the price reaches $.948 per ton there will be a profit from operation of $372,000, which will pay for operation, for debts, and for present administration charges.

9. While waiting, hoping, and working for better coal prices, costs of operations are to be standardized:

(*a*) By revaluing all the lands and equipment, thus reducing future operating overhead charges.

(*b*) By putting the management of inside and outside operations in the hands of a competent and experienced man of reliable character.

(*c*) By giving him all the assistance possible from modern business organization and methods adopted by other bituminous coal mine operations and industrial enterprises.

(*d*) By concentrating operation at that plant, or those plants where coal can be mined most cheaply.

(*e*) By investigating the advantages, if any, to be derived from coking the product of these mines.

(*f*) By investigating the advantages, if any, of establishing a washery at the mines.

Standard Table of Costs.—In making its investigations the committee attempted to determine a standard cost per ton of mined coal for a standard output, which was assumed at 3,000,000 tons each year.

The standards adopted for immediate use were:

1. The present standard mining scales for mining labor, $.485.

2. Current rates of wages for a minimum amount of other efficient working labor, $.175.

3. Moneys for supervision, supplies, and other bills, taxes, insurance, etc., an efficient minimum, $.07.

4. Depreciation charges based on revaluations, on experience, and on the present ascertained coal reserve tributary to operating plants, $.06.

5. Interest at 6 per cent. per annum on reappraised values of coal reserves, mining buildings, equipment, etc., actually used for mining operations, $.067.

The company has other expenses not standard and not directly appertaining to mining operations. These are:

6. Interest and other charges on investments at present inoperative, $.029.

7. Excessive interest load, due partly to investment in elaborate and unnecessary plants, partly to deficits accumulated from former

years, and partly to other causes, $.035.

8. High costs of administration of the company's business.

SUMMARY OF COSTS	
Operation	$77,294
Maintenance	14,156
General expense, excluding insurance	37,912
	$129,362
Less allowance for mining operation	$48,000
	$81,362
Cost per ton	$.0271

The output of coal can fluctuate from no tonnage, if the mines are closed, to a maximum daily tonnage of 17,000 tons.

If this maximum of 17,000 tons daily or an output per year of 4,250,000 tons, could be attained, it would reduce mining costs about as follows:

COST PER TON	
Mining labor	$.455
Other labor	.150
Operation	.060
Depreciation	.060
Interest	.045
Total	$.770

With a daily output of 12,000 tons or 3,000,000 tons annually, the cost per ton would be as follows:

COST PER TON	
1. Mining labor	$.485
2. Other labor	.175
3. Total working pay roll (1 and 2)	$.660
4. Operations	.070
5. Depreciation	.060
6. Interest	.067
7. Total overhead charge (4, 5, 6)	$.197
8. Total standard cost per ton of coal (3 and 7)	$.857

The whole practical problem is to attain the standard costs, and it is this aspect of the situation which underlies the report.

Because the future is more important than the past, standard costs for operation for the next year have been established.

Having set up standards of cost for varying output and having established current efficiencies one is able each month to show the exact losses due to inefficiencies, and their cause.

It is not stated vaguely that you ought to mine for $.10 a ton less. On the contrary the $.10 above standard is subdivided into perhaps 50 different items and not only the amount of, but also the cause of the excess or unstandardized cost in each is shown.

If you know where and when and why losses occur it is usually possible to prevent them. The science of efficiency is applied to any business in a similar manner. It is possible to have a very great deal of system without any efficiency. It is possible to have a minimum of system, a minimum of strenuousness, yet very great efficiency.

Cost of Mine Cars

Written for The Colliery Engineer

It is curious to note that during the last 35 years there has been little if any improvement in the construction of mine cars or their manipulation which has reduced the cost per ton in mining. Thirty-five years ago the average cost was 2.52 cents per ton in the anthracite fields; at present it is about 2.73 cents in the bituminous fields. If this cost could be reduced 1 cent per ton it means $1,000 to the company mining 100,000 tons per annum. Wooden mine cars are patched and repaired, and only when they are smashed outright are they considered a loss; however, their average life is 3½ years; that is, by that time they contain nothing of the original car. This is equivalent to a depreciation of 28.57 per cent. on the cost of the original car, and a charge of 28.57 per cent. for a renewed car at the end of 3½ years.

The repairs on a wooden mine car per year are between 20 and 40 per cent. of the original cost, on an average say 28.57 per cent. Car wheels and axles will last 1 year, which makes their yearly average cost 28.75 per cent. At the end of the 3½-year period there is a charge of 114.28 per cent. against the cars, but this is not all, as the following assumption will show. If a mine works 260 days, a car holding 2 tons making six round trips of 2 miles daily, in 3½ years will have traveled 10,920 miles and carried 10,920 tons.

It is probable that a car will use 1 gill of oil per day worth 1 cent in the car boxes or $9.10 in 3½ years. Assuming that the car originally cost $50, the cost for cars per ton of coal would be

Interest on $50, 3½ years	$9.10
Wheels and axles, 2½ pairs @ $24	60.00
Depreciation of cars, 14.285 × 3½ years	50.00
New cars to replace the old	50.00
Repairs on cars	50.00
Oil and oiling	9.10
Total outlay	$228.20

Cost per ton of coal produced 2.1 cents per ton. This is conservative, for actual returns from bituminous mines average 2.73 cents per ton. If to this is added additional equipment to care for increased output, the cost will probably reach from 3 to 4 cents per ton. The wear on wooden cars is due to the sudden jerks and bumps that they undergo when being hauled, to shifting of load in improperly loaded cars when rounding curves, to jumping the track, and to dumping.

Wooden cars depend for their strength and stiffness upon car irons, bolts, and sound planks. Shrinkage and rotting of the wood and the rough usage they undergo soon enlarge the bolt holes, loosen the nuts, and the boxes finding play, the axles swing and put the cars in condition for jumping the track.

After the car has jumped the track once or twice new bottom planks are put in if the car has not been badly wrecked. This of course is like locking the barn after the horse has been stolen; however, the way out of this trouble is by making use of angle-bar trucks.

When loaded moving cars are suddenly brought to a standstill the load keeps on moving after the bottom has stopped and this racks the car body, particularly since the door is not so rigid as the sides and end. Much of this wear may be prevented by making use of rotary dumps since the car will then need no door, and the jar from the dump horns is not so great.

One of the greatest items of expense connected with mine cars is the wheels. To melt iron and pour it in a mold is not sufficient to make a durable wheel, but this practice frequently accounts for wheels furnished by the same maker wearing unequally. The treads of car wheels will last longer if chilled; however,

special mixtures of iron must be used in the foundry, if uniform wheels of equal wearing quality are to be produced. When a suitable mixture has been found the foundryman should adhere to it. However, the trouble does not end with the tread, for soft hubs are a source of expense and annoyance. When these funnel, the car is liable to jump the track and cause a wreck. In bituminous coal mines the prevailing practice is to use wheels loose on the axles; and when the cars round curves, the bearings are not true, which causes the hub to wear funnel shape, making it necessary to discard the wheel to prevent wrecks. Roller bearings will in a measure prevent this funneling, since they are incased in a flexible bushing and the axle does not come in direct contact with the hub.

In anthracite mines heavy cars are constructed, the main idea in mind being to have them withstand rough usage. The wheels are pressed onto the axle and both turn together in journal boxes which are arranged inside or outside the wheels to suit conditions. Few roller bearing wheels are used, the objection being raised by the operators that there are too many parts to the bearing. The manufacturers of roller bearings reply to this objection by saying the anthracite operators use such poor iron axles that roller bearings could not be induced to work properly. Anthracite operators use every endeavor to construct strong and durable wooden cars, but even with their heavier and more expensive cars, the cost per ton for cars is not less than that of bituminous operators. From personal observation the writer believes that this, so far as wheels are concerned, is due to the prevailing use of sprags in stopping the loaded cars, and to the almost universal method of end dumping. Some companies are now making use of axle brakes in those places where formerly sprags were in general use. When the levers are worked properly axle brakes will not bend car axles.

The wear on car bodies comes from the cars bumping together, jumping the track, and back switching after being dumped. When coupled in trains the chains are usually four links long* consequently there is considerable jerking when the train stops. It is also customary to bump the cars off the cages and dumps, and frequently on back switching the cars come together so hard the tail end of the car almost rises off the rails and quivers.

Anthracite mine cars should be improved by gradually replacing old cars, as they wear out, with improved new cars and purchasing new cars as increased rolling stock is needed. In some anthracite mines several sized cars are required to conform to the thicknesses of the several coal seams being worked; this, however, does not alter conditions met with in haulage, dumping, etc.

Where mine cars are not subjected to sulphur water, steel cars have some advantage over wooden cars. The life of a good steel car is twice that of a wooden car, and its first cost is two and half times as much. The cost of maintenance is about half that of wooden cars when the conditions are favorable for their installation. In some places steel cars will not wear so well as wooden cars, particularly where the steel sides are thin, and they are not kept painted inside and out. Where there is sulphur water which comes in contact with the steel, where the cars are left standing in return airways, or outside loaded with wet coal, oxidation soon pits the steel. Under such conditions steel cars are difficult to keep covered with paint because of abrasion received during loading and discharging. Those advantages which steel cars have over wooden cars, are stiffness, strength, capacity, and tightness. It follows from what has been stated that field conditions have much to do with the economical use of mine cars; for example, in the Flat-Top Pocahontas field, where the mines are above water level, steel cars will wear two times as long as in the shaft mines in western Pennsylvania.

*Where 500 cars are hauled daily 26.45 tons of coupling links are hauled, in case of round trips 52.9 tons.

Relative to roller bearing wheels, one engineer states that one company which had 550 sets of roller bearing wheels made comparative tests with solid hub wheels with the following results:

Twenty cars loaded with 3 1/10 tons coal each, hauled 3,250 feet and back three times.

Test of Haulage Powers—Solid Hub vs. Roller-Bearing Wheels

Trips	Solid Hub			Roller Bearing		
	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
Time of round trips, minutes	23.5	10.25	11.0	8.66	7.16	6.66
Average amperes	185	169	180	155	156	152
Average volts	478	472	460	460	469	467
Kilowatts	88.4	80.0	82.9	71.3	73.16	71.0
Kilowatt hours	34.6	13.7	15.2	10.6	8.75	7.9

Average For Three Trips

	Solid Hub	Roller Bearing
Time	14.9 min.	7.5 min.
Average amperes	178	154
Average volts	470	465
Average kilowatts	83.78	71.81
Average kilowatt hours	21.0	8.8

The saving in power, shows a saving in wear which reflects a saving in money.

The State Mineralogist, Ferry Building, San Francisco, Calif., announces that samples (limited to three at one time) of any mineral found in California may be sent to the Bureau for identification, and the same will be classified free of charge.

No samples received from points outside the state will be determined. Samples should be in lump form if possible and marked plainly on the outside of package with name of sender and post-office address and charges prepaid. A letter should accompany the sample stating county in which it was found, approximate size of deposit, etc.

The Colliery Engineer continues to classify rocks and minerals free of charge, as it did when known as Mines and Minerals.

Anthracite Mine Engineering

Some Phases of the Efficiencies in Mine Engineering in the Northern Anthracite Field

By George W. Engel*

THE subject matter of this paper is submitted for the purpose of stimulating investigation to the end that an efficient engineering organization may be perfected for all coal companies alike. To prevent the personal equation overriding any one point involved, it is suggested that a committee of capable mining engineers be appointed to investigate the various systems of mine surveying at present in use by anthracite companies and embody the best of them in a report, to the end that efficiency may be attained.

Since surveying forms the basis for most of the activities in the mining engineering department of a coal company any improvement in surveying practice promotes greater efficiency in the department as a whole. Having this idea in view, the different systems for making surveys and performing office work in connection therewith are to be discussed, four systems being taken for this purpose.

FIRST COMPANY'S SYSTEM

This company uses the "carbon system" for recording the surveys, and it has been in most successful use for the past 9 years.

In the "carbon system" there are three special books used, termed the Transit Book, the Side Note Book, and the Office Book. Both the Transit Book and the Side Note Book, have double leaves, perforated along the front edges. The loose end of this double leaf, or that part upon which the carbon impression is made, folds back under that part of the leaf which is secured to the back of the book. After the one page of notes has been made and carboned, the leaf is again folded and the carbon impression made upon the other side; thus both sides of the original and carbon are filled. The perforations along the front edges of the leaves permit them to be folded both ways.

The Office Book when closed is 7 in. × 8 in. It contains stubs 2¾ inches wide. As soon as the transit sheets are received they are pasted to the stubs in the Office Book; the extra width of stub is used for office calculations, principally the latitudes and departures and their totals. As soon as the coordinate values and elevations are entered in the Office Book, it is ready for the map. The office men calculate and map the work of the corps at the mines, and when the survey is finished the map work is also nearly finished. Any errors that develop are brought to the attention of the transit man and corrections made by him before he leaves the mine.

The relative value of a survey is the quickness with which it can be reduced to map form for inspection at the office and sent to those interested at the mine. The carbon system has the following advantages:

First. The carbon notes appear as originally taken by the corps, which eliminates any possibility of error due to copying (while a question might arise as to the absolute accuracy of copied notes, there can be no question as to carboned work).

Second. The labor of copying is eliminated, and it is possible to keep the office work nearly up to the work of the surveying corps, and results are attained in shorter time.

In one of the recent semiannual surveys, where 608 stations were put up, and the linear feet measured 15 miles, the blueprints were in the hands of the division superintendent and mine foreman 1 week after the survey was completed. In another recent semiannual survey, where the linear feet measured 14.4 miles, the prints were sent to the division superintendent and mine foreman 3 days after the completion of the survey.

A mine foreman at another colliery stated that it took from 4 to 6 weeks after the completion of the semiannual survey to get his blueprints.

A few words relative to some of the details in the field or mine work will possibly be of interest at this stage of the paper. The courses are determined by readings from the continuous vernier, with 0° and 360° at the north, instead of from deflection angles. For each course three readings are made, first, the continuous vernier plate reading; second, the quadrant vernier reading; and third, the needle reading from the compass; the two readings from the plates serve as checks. The tidal elevations and the coordinate positions are proven by frequent ties. The linear measurements are made by 200-foot steel tapes, the reels for which are of aluminum, specially designed by the Mining Department; the first being made in Scranton 6 years ago. This reel is star shaped, has a winding drum 6 inches in diameter, weighs 3⅜ pounds, and is of sufficient size for either a 200-foot or 300-foot tape ¼ inch wide.

The "survey stations" and "line stations," or so-called "squares," are made by drilling holes in the roof into which a hardwood plug and afterwards a metal eye spad are driven. The number of the survey station is painted with white lead upon the roof or rib, and a circle painted around the station. The line stations are not numbered, but are shown by a square painted around the station, hence the name "square." To further differentiate the line stations from the survey stations, the faces of the spads are placed at right angles to and back of the survey stations or spads. Carbide lamps with extra large reflectors are used in surveying, except where safety lamps are necessary.

The transit work and the side-note work are kept in separate books (some companies keep both in one book). The station numbers are continuous for all the beds at any

*Mining Engineer, Scranton, Pa.

particular colliery, and the work for all the beds is put into the one book instead of having a separate book for each bed, as is the case with some other concerns. Sketches are used in conjunction with the Side Note Book, in which also is recorded coal sections, dip or inclination of the bed, faults, and any other necessary data. Fig. 1 shows the form of daily report sent into the office by the transit men.

ENGINEER'S DAILY REPORT

COLLIERY_____ BED_____ SURVEY_____ SHIFT_____ DATE_____ 191____

Names of Engineers and Company Men	Left Scranton	Arrived Colliery	Time Outside	Began Inside Work	Quit Work	Left Colliery	Arrived Scranton	Delays	Expenses, Carfares, and Mileage	Total Shifts to Date	Rate	Cost Per Foot to Date

Number vertical angles	Future work next shift, date
Number levels	Colliery
Number side sights	Vein
Number squares or line stations	Location
Number of stations	Kind of work
Linear feet measured	Days or nights or both
Number of side notes	Tools and supplies left or at colliery
Number of sections	
Total linear feet measured and stations to date	

Fig. 1

The field and mine work consists of

1. Semiannual or six months surveys.
2. Monthly surveys.
3. Surveys in neighboring mines.
4. Surveys for surface improvements and real estate.
5. Inspection for pillar robbing.
6. Inspection work for royalties.
7. Work in connection with the filling of mine openings with rock, culm, and refuse.
8. Work for tax purposes, including coal, surface lots, and surface improvements.
9. Surveys of old mine workings.
10. (See Company No. 3.) Monthly yardage measurement of miners' work.
11. Tonnage estimates.
12. Surveys for bore holes.
13. Miscellaneous — includes helping the pay clerks, special work in connection with legal matters, minimum royalties, estimates for improvements such as sinking shafts or driving rock slopes and tunnels, profiles for grading in the mines, etc. Of the items enumerated, special mention is made of No. 2, or monthly surveys; No. 5, or inspection for pillar robbing; No. 6, inspection work for royalties; No. 8, for tax purposes, and No. 11, for tonnage estimates.

2. Monthly Surveys.—This work is mostly devoted to giving centers for chamber and gangway driving. Every chamber depends for its starting point and centers upon points given by the mining engineers. All chambers in any particular seam and section of the mine are not only parallel and equidistant, but are vertically above or below chambers in other seams, where the strata between seams are less than a predetermined thickness. In such cases the pillars of coal are columned, but where pillars are not columned all the chambers are given points and centers so as to make them line parallel and equidistant. For distances at which stations must be put up along the gangway the surveyor uses the table given in Fig. 2.

For example: If the angle between the gangway course and the chamber course is 45 degrees, and the chamber lines are to be 50 feet apart, at the intersection of 50′ C. and 45° in the table, we get 70.70 feet as the distance to measure along the gangway.

The lining of chambers and gangways gives the mining department

DISTANCES FOR CHAMBER CENTERS ON ANGLE TURNED FROM CHAMBER COURSE

Deg.	40′ C.	50′ C.	60′ C.	70′ C.	Deg.	40′ C.	50′ C.	60′ C.	70′ C.
30	80.00	100.00	120.00	140.00	60	46.19	57.74	69.28	80.83
31	77.67	97.09	116.50	135.92	61	45.73	57.17	68.61	80.04
32	75.49	94.36	113.21	132.10	62	45.31	56.62	67.95	79.28
33	73.46	91.81	110.17	125.53	63	41.99	56.11	67.34	78.56
34	71.53	89.41	107.30	125.18	64	44.50	55.62	66.76	77.88
35	69.75	87.17	104.61	122.04	65	44.13	55.17	66.20	77.24
36	68.05	85.07	102.07	119.09	66	43.79	54.73	65.68	76.62
37	66.46	83.08	99.03	116.32	67	43.46	54.32	65.19	76.04
38	64.97	81.21	97.45	113.69	68	43.14	53.93	64.71	75.50
39	63.56	79.44	95.34	111.23	69	42.85	53.56	64.27	74.98
40	62.23	77.80	93.34	108.90	70	42.56	53.21	63.85	74.49
41	60.97	76.21	91.45	106.69	71	42.31	52.88	63.45	74 03
42	59.78	74.72	89.67	104.62	72	42.06	52.58	63.08	73.60
43	58.65	73.31	87.98	102.64	73	41.83	52.28	62.74	73.20
44	57.58	71.98	86.37	100.76	74	41.67	52.01	62.42	72.82
45	56.57	70.70	84.85	98.99	75	41.41	51.77	62.11	72.47
46	55.61	69.51	83.40	97.32	76	41.23	51.53	61.83	72.14
47	54.70	68.37	82.04	95.71	77	41.05	51.32	61.57	71.84
48	53.83	67.28	80.47	93.57	78	40.89	51.11	61.34	71.57
49	53.00	66.25	79.50	92.75	79	40.75	50.97	61.12	71.31
50	52.22	65.27	78.32	91.38	80	40.62	50.77	60.92	71.08
51	51.48	64.33	77.20	90.08	81	40.50	50.63	60.75	70.87
52	50.76	63.46	76.14	88.83	82	40.39	50.50	60.59	70.69
53	50.09	62.60	75.12	87.65	83	40.30	50.37	60.45	70.53
54	49.44	61.80	74.16	86.53	84	40.22	50.27	60.33	70.39
55	48.83	61.04	73.24	85.45	85	40.15	50.19	60.23	70.27
56	48.25	60.31	72.37	84.44	86	40.10	50.12	60.15	70.17
57	47.69	59.62	71.54	83.46	87	40.05	50.07	60.08	70.10
58	47.17	58.96	70.76	82.55	88	40.02	50.03	60.04	70.04
59	46.66	58.33	70.00	81.66	89	40.01	50.01	60.01	70.01

Fig. 2

much extra work, which will increase when the thinner seams of coal are being mined. In addition to requiring two stations at each chamber opening, the stations have to be advanced up the chamber, if for inequalities in the seam or length of the chamber, the miner cannot see the face. This work has been done largely in the past by the mine foreman, with a compass, but it is beginning to be recognized by coal companies as part of the duties of the mining engineer.

5. *Inspection for Pillar Robbing.* Every coal pillar is numbered, because it is essential for inspection purposes, and also for estimating the tonnage mined and the coal remaining. Monthly mine inspections are made and pillar robbing progress is posted on the "pillar map," and with the data obtained the statement shown in Fig. 3 is tabulated.

This statement gives the actual production in tons from each pillar, and is compared with the number of tons that should be secured according to office and map calculations. This test can be applied to every pillar, or to an occasional one from time to time. Probably the latter method will be sufficient, because all the pillars are accounted for in the statement, Fig. 4; besides, results are shown for the entire areas robbed, and for periods to meet each case, say every six months or every year.

6. *Inspection for Royalty.*—Personal inspection by engineers of the Engineering Department is made when mining under a property having a large number of surface lots, many of which might be small in area, as at one colliery where the individual lots number between 100 and 110. Where the lots are large in area and small in number, the mine foreman makes the necessary returns from which the royalty tonnage is figured, the Engineering Department making checks from time to time, by means of that portion of the statement, Fig. 5, showing "Tons Per Foot-Acre" from the "Mined Out and Removed" and from the "Mined Over" columns.

8. *Work for Tax Purposes.*—All the work under this heading, including coal, surface lots, and surface improvements, is performed by the Mining Department. With most companies the quantity of coal is determined by the mining engineers, leaving to the Real Estate, Tax, and Legal Departments the laborious and detailed work of comparing and checking the Tax Collector's bill. One not having done this work during the past few years has no adequate conception of the task.

11. *Tonnage Estimates.*—See Fig. 5, Statement of Coal Mined and Unmined. For tonnage estimates special maps are used having upon them the various surface properties, the numbered pillars, the mine openings, the out-crops or mining limits of the coal beds, the faults or other unusual features; also the coal sections, each lot having its separate set of coal section numbers and pillar numbers, beginning in each case with No. 1. The area of each individual pillar is determined by the planimeter. The mined over area, or superficial area of present pillars, is calculated from the map, also solid coal area, faulty area, barrier pillar area, area of lot or tract, etc. The final results under the "Unmined Portion" of the statement show the tons of coal remaining. The final results under the "Mined Portion" of the statement showing the number of tons per foot-acre won from the mined and removed areas as well as from the mined over areas. Some of the statements are 4 ft. 2 in. × 3 ft. 5 in. for each bed of coal, and at one colliery the statements, if placed edge to edge, would be 20 feet 10 inches long.

Office results accomplished are:

1. 100-foot-scale mine maps.
2. 100-foot-scale mine maps for the mine inspector.

Colliery _____ Bed _____ Date _____

Number of Pillar	Date Began	Date Ended	Map or Square Area Pillar	Height of Coal Pillar	Area in Cubic Feet	Number of Cars	Number of Mined Tons	Number of Tons All Sizes Mined	Number of Tons All Sizes Calc.	Per Cent. Won Based on — Tons Per Foot-Acre	Remarks

Fig. 3

Statement of Pillar Coal

Colliery	Date	Tract	Bed	Thickness: Pillar	Thickness: Bottom Bench in Cross-Cuts	Acres of Solid Pillars: Robbed and Partly Lost	Acres of Solid Pillars: Caved and Wholly Lost	Acres of Solid Pillars: Total	Per Cent. of Solid Pillars: Robbed and Partly Lost	Per Cent. of Solid Pillars: Caved and Wholly Lost	Foot-Acres of Solid Pillar: Robbed and Partly Lost	Foot-Acres of Solid Pillar: Caved and Wholly Lost	Foot-Acres of Solid Pillar: Total	Yield From Robbed Area: Cars	Yield From Robbed Area: Tons	Yield From Robbed Area: Tons Per Foot-Acre	Yield From Robbed Area: Minable Per Cent. of — Tons	Yield From Robbed Area: Minable Per Cent. of — Tons	Yield From Robbed and Caved Area: Cars	Yield From Robbed and Caved Area: Tons	Yield From Robbed and Caved Area: Tons Per Foot-Acre	Yield From Robbed and Caved Area: Minable Per Cent. of — Tons	Yield From Robbed and Caved Area: Minable Per Cent. of — Tons	Remarks

Fig. 4

3. 400-foot-scale mine maps.

4. 400-foot-scale mine maps for coal-tax purposes.

5. 100-foot-scale mine maps to show mine openings filled with rock, culm, and refuse.

6. 100-foot-scale maps for insurance, buildings, surface improvements, and taxes.

7. 100-foot-scale maps for tonnage estimates.

8. Royalty reports.

9. Bore-hole columnar section drawings on 20 feet = 1 inch scale and Bore-Hole Book records.

10. Maps for miscellaneous work.

11. Survey records.

The following is an example of the results and efficiencies in a recent semiannual or six months survey at one colliery:

The four-man corps measured 15 linear miles, put up 320 survey stations and 288 squares, a total of 608 stations. The measurement per man per day worked was 587 feet. The finished blueprints were in the hands of the mine foreman and his assistants 1 week after the survey was completed at the mine.

In another semiannual survey the four-man corps measured 17 linear miles, or 788 feet per man per day.

If the blueprint facilities had been up to date, the blueprints would have been finished 1 day sooner. A better performance than this was where but 3 days elapsed from the end of the survey to the time when the blueprints were sent to the men at the mines. During the monthly surveys preceding this semiannual survey, the mine corps put in 295 survey stations and 265 squares, a total of 560 stations; which, with 608 stations of the semiannual survey, makes 1,168 stations in 6 months. The total linear measurement for the 6 months period was nearly 30 miles. The production of coal per station put in was 217½ tons. Neither of the other companies here considered have the necessary data so as to make a comparison of the figures just quoted.

THE SECOND COMPANY'S SYSTEM

Field, Mine, and Office Work.—For titles to numbers 1, 2, etc., see first company's numbers 1, 2, etc., under Field, Mine, and Office Work.

1. Triannual surveys are made instead of semiannual surveys. The Transit Notes and the Side Notes are recorded in the same book—the left page for transit work and the right page for side notes, and a separate book is kept for each coal bed. The courses are determined by deflection angles. The deflection angles are doubled, which actually means that the angle is measured twice. The needle is read for each course and recorded. Linear measurements are read twice. This method is more consistent, and is sure to be more accurate than in cases where the transit work is checked, but linear measurements only made once, for in a tie survey the chain is just as important as the transit. As an example of some excellent work, it is stated that a drainage tunnel, about 7,000 feet long, was driven from both ends and met in the middle within 4½ inches for line, and 1 inch difference in elevation. For this tunnel work a shaft was plumbed and 1,100 feet surveyed inside, with some measurements from 28 to 30 feet between stations. The extent of the survey on the surface from the same shaft was 8,200 feet.

In the regular mine surveys, the stations consist of 3/16-inch diameter

STATEMENT OF COAL MINED AND UNMINED

MINED PORTION

(*Read from right*)

Tons Per Foot-Acre		Acres One Foot Thick						Pillars or Second Mining		Percentage	Acres of Solid or First Mining											
		Tons Mined Up to Date	Pillars or Second Mining			First Mining																
Mined Out and Removed	Mined Over		Acres Not Robbed or Abandoned	Acres Robbed and Abandoned	Pillars Left in Before Robbing Began	Mined Out and Removed	Mined Over	Acres of Pillars Not Robbed or Abandoned	Acres of Pillars Robbed and Abandoned	Left in Pillars	Mined Out and Removed	Pillars Left in Before Robbing Began	Acres Mined Out and Removed	Acres Mined Over	Coal Not Mined Over Left in Solid	Acres of Mineable Coal	Acres of Barrier Pillars	Acres Faulty and Dangerous of Bed	Acres of Bed	Acres Barren of Bed	Acres in Lot or Lease	Number of Lot	Colliery	Tract	Bed

FIG. 5

UNMINED PORTION

(*Read from left*)

Acres			Thickness	Foot-Acres		Basis For Tons Minable Per Foot-Acre			Tons Minable Per Foot-Acre From			Tons Minable From						Total Minable Tons Remaining in Solid and Present Pillars	Remarks
Solid	Superficial Area of Present Pillars	Number of Sections		Solid	Pillars	Of Solid			First Mining of Solid	Superficial Area of Future Pillars	Superficial Area of Present Pillars	Solid or Present First Mining and Future Pillars	First Mining of Solid	Future Pillars	Solid or First Mining and Future Pillars	Present Pillars	Total Present and Future Pillars		
						First Mining Per Cent.	Future Pillars Per Cent.	Of Future and Present Pillars Minable Per Cent.											

FIG. 5—(*Continued*)

holes drilled into the roof by brace and bit, and this point carried to the floor by a plumb-bob. The station numbers are painted and are continuous for each bed only. Oil lamps are used. For the side notes, figures and characters are used instead of sketches, an example of which is shown in Figs. 6 and 6*a*.

2. Instead of monthly surveys the gangway and chamber lining is carried on by a corps which remains at the mines. This work is not put upon the maps, and no more record is kept of it than if it was made by the mine foreman with a compass in the old way. Pillars are columned where necessary.

3. Surveys in neighboring mines are most thorough.

5. Pillar robbing is posted from blueprints sent into the office every 4 months by the mine foreman.

6. The Mining Department pays very little if any attention to royalty work, it being done through other departments.

7. No record is kept of filling mine openings with rock, culm, and refuse.

8. Coal is the only item considered in connection with taxes.

9. Some surveys are made in old mine workings.

10. No monthly yardage measurements of miners' work is made.

11. No particular and detailed coal tonnage estimates are made, except as the tax estimates show.

12. Bore-hole surveys are made.

13. Miscellaneous work about the same as the first company.

THE THIRD COMPANY'S SYSTEM

The Field, Mine, and Office Work. For titles to numbers 1, 2, etc., see first company's numbers 1, 2, etc., under Field, Mine, and Office work.

1. Instead of semiannual surveys, quarterly surveys are made. For survey stations the eye spad is used and the station numbers are painted with white lead. Chambers and gangways are not lined by the Mining Department in all cases. Pillars are columned where necessary. Oil lamps are used. The line stations are differentiated from the survey stations by exact linear measurements to each. The continuous vernier with 0° and 360° south is used. But one vernier reading from the plate and one compass reading is made for each course. All coal bed notes are put in one book. A separate Side Note Book and a separate Transit Book are used. In side notes the so-called "continuous" system is used. This means that the chambers are connected in groups of two or more instead of one chamber at a time, which is a decided advantage, because there can then be no question as to any cross-cut connections or counter gangways driven across chambers. The ticket number of the miner of every place is recorded in the Side Note Book. This is for royalty purposes.

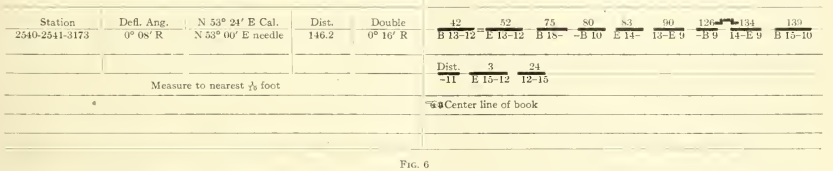


FIG. 6

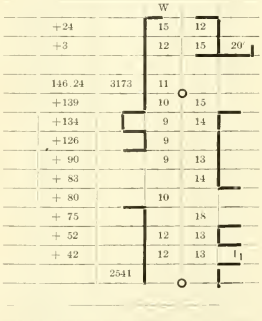


FIG. 6 (*a*)

Great care is exercised in preserving the survey records; the purpose being to have duplicates —which are kept in a separate vault. Hence the survey is copied upon loose working sheets and the required calculations made thereon. The work is put upon the maps from these sheets. These loose sheet data are again copied into a permanent record book, which book is put in the vault, its mate being the original survey which occupies a separate vault. Similarly the side notes are copied to a Record Side Note Book, which is kept in a separate vault from the original side notes.

2. Monthly surveys are not made, though chamber and gangway lining is done to some extent by the Mining Department.

3. Neighbors' mines are only surveyed in special cases.

4. Surveys for surface improvements and real estate, are made by the Mining Department, with the exception of surface lots, which are cared for by the Real Estate Department.

5. Inspection for pillar robbing. Pillars are not numbered; they being identified by the name of the road or the gangway and the number of the chamber they are next to. Robbing is checked by the mine corps, but no detailed calculations are made of pillars to find the efficiency in robbing.

6. Inspection for royalties is done in a most commendable manner. The mine foreman and colliery clerk are jointly responsible for the entries into the original book at the mine. At the end of the month this book is sent to the engineering department, where each entry is checked to the mine map. Should any question arise, the Side Note Book is consulted. (As stated, the miner's number is recorded in the Side Note Book at the time of survey.) Results are tabulated upon distribution sheets, from which the totals are transferred to a Statement of Coal Mined, which the Chief Mining Engineer signs, and then turns over to the Auditing Department. See Fig. 7.

7. Work in connection with filling mine excavations with rock, culm, and refuse, is performed by the mine corps and posted on separate maps, which show whether the rock has been loosely put in or walled up with care.

8. For taxation purposes, the quantity of coal is determined by the Mining Department, and submitted to the Real Estate Department, whose business is to look after coal taxes in conjunction with surface lots and surface improvements.

9. Some old mine surveys are made.

10. Monthly yardage measurements of miners' work is made by the mine corps and entails considerable labor upon the Mining Department. Most companies doubt the utility of this branch of the work and are satisfied with the measurements made by the mine foreman, as the miner, being an interested party, will be sure to see that he is getting his due from the mine foreman.

11. Tonnage estimates. Detailed coal tonnage estimates are not made, except as the tax estimates show.

12. Bore-hole surveys are made.

13. Miscellaneous, about the same as the first company.

THE FOURTH COMPANY'S SYSTEM

The Field, Mine, and Office Work. For titles to numbers 1, 2, etc., see first company's numbers 1, 2, etc., under the heads Field, Mine, and Office Work.

1. Semiannual surveys are made regularly. For survey stations the eye spad is used and the station numbers are painted with white lead upon the roof or rib. The method of putting up stations might be followed to advantage by others. Where the rock is not too hard a ratchet drill is used to make a small hole in the roof. The diameter of this hole is a little larger than the stem of the spad, so that a mere match stick will be large enough to put in the hole preparatory to driving in the spad. One can readily understand the saving in labor by this method when it is compared with making each hole with a drill and hammer.

Exact measurements are made to all line stations, partly for the purpose of not getting them confused with the regular numbered station, and partly (in extreme cases) to use the course between them and the regular station for a base to continue future surveys.

The continuous vernier is used to measure the horizontal angles. The plate is graduated so that 0° and 360° appear upon the south. Two readings are taken, that of the vernier plate and that of the compass needle. The transit and the side notes are recorded in the same book, the transit notes being upon the two leaves opposite, and the side notes upon the two following leaves. For each bed of coal there is a separate book. Thus, when a survey is finished in one bed, the book is sent to the office. The notes are copied to the office book, coordinate and other calculations performed, and the work is ready to be plotted upon the maps. Levels are determined after the regular survey is completed. Chambers and gangways are not lined in all cases. Coal pillars are columned where the rock interval between beds is 50 feet or less. Oil lamps are used. Daily reports are sent to the office by the surveying corps.

2. Monthly surveys are not made although chamber and gangway lining is done to a considerable extent.

3. Neighbors' mines are surveyed only in special cases.

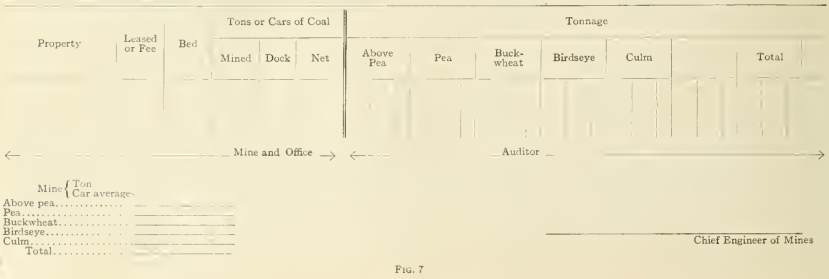


Fig. 7

4. All surveys are made for surface improvements and real estate.

5. Inspection for pillar robbing. Pillar robbing is posted by the mine foreman upon blueprints and then transferred by the office force to the maps. Inspections are made only outside of the Mining Department. No detailed calculations per pillar are made.

6. Inspection for royalties. In this the details could be followed with great credit by any one in the coal business. Two so-called "Separation Books" are used, both exactly alike. One is kept in the office and one is in the mine foreman's possession. The mine foreman's book is checked by men from the Mining Department force who go over the maps with the mine foreman. The mine foreman then calls off his data to the colliery clerk who makes entries into the Coal Book from which the clerk makes out a statement of properties and cars. This goes to the Mining Department where it is checked and corrections made therein. This sheet is sent to the mine foreman, who then puts it into his Separation Book, a copy being retained in the Mining Department for their Separation Book. Any changes in this last named sheet are brought to the attention of the colliery clerk, who then prepares a final sheet, which is signed by the mine foreman and forwarded to the Auditing Department, by whom it is referred to the Mining Department for final approval. It leaves the Mining Department with the signatures of the chief engineer, district engineer, and superintendent of the Coal Mining Department. All the work is really based upon the mine foreman's Separation Book, for in any system the mine foreman must make the original entries of properties and cars mined. However, the correctness and efficiency of any system depends upon methods of checking the mine foreman by the mine engineers. See Fig. 8.

7. The filling of mine openings with rock, culm, and refuse is posted upon the regular 100-foot maps.

8. As to taxes, the quantity of coal only is estimated by the mine engineer.

9. Considerable time is given to surveying in old mine workings, probably more work of this nature being done than by any other company here mentioned.

10. Monthly yardage measurements of miners' work are not made.

11. Occasionally, tonnage estimates are made, but only upon leased lots.

In the marking of per cent. of efficiency the survey work of the mine and field is divided into 13 divisions. Each division is given a maximum weight or number of points depending upon its importance, viz.:

		Maximum Points or Per Cent.
1.	Monthly survey	15
2.	Semiannual or six-months survey	14
3.	Surveys for surface improvements and real estate	12
4.	Monthly yardage measurement of miners' work	11
5.	Inspection for pillar robbing	10
6.	Inspection work for royalties	9
7.	Tonnage estimates	8
8.	Survey of old mine workings	6
9.	Surveys for bore holes	5
10.	Surveys in neighboring mines	4
11.	Work in connection with the filling of mine openings with rock, ashes, and refuse	3
12.	Work for tax purposes including coal, surface lots and surface improvements	2
13.	Miscellaneous	1
	Total points	100

Thus the maximum number of points is 100. By this method one company's work became 71 per cent.; another's, 58; another's, 79; another's, 47; the highest being 79 and the lowest 47 per cent.

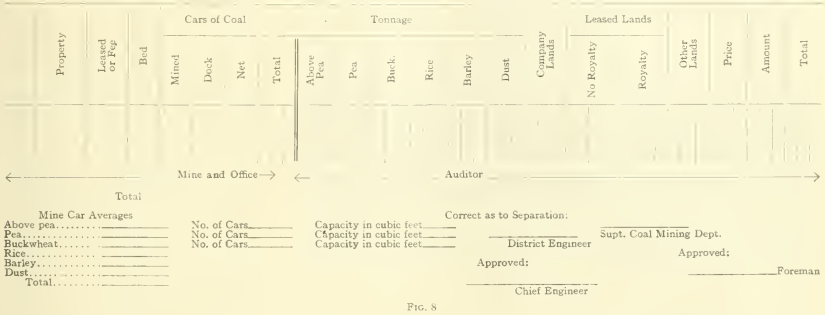


FIG. 8

The office work is also divided into 13 divisions, the maximum number of points being 100 as before.

The divisions and maximum markings follow:

		Maximum Points or Per Cent.
1.	100-foot-scale mine maps	25
2.	Survey records	19
3.	Royalty reports	13
4.	20-foot-scale bore-hole columnar section. Drawings and bore-hole book records	10
5.	400-foot-scale mine maps	6
6.	100-foot mine tracings	5
7.	100-foot-scale mine maps for mine inspectors	4
8.	400-foot mine tracings	4
9.	400-foot-scale mine maps for coal taxes	3
10.	100-foot-scale mine maps for insurance buildings, surface improvements, and taxes	3
11.	100-foot scale mine maps for tonnage estimates	3
12.	Maps for miscellaneous work	3
13.	100-foot-scale mine maps to show mine openings filled with rock, ashes, and refuse	2
	Total points	100

The marks or per cent. of efficiency follow, viz.:

One company shows 75 per cent.; another, 82; another, 67; and the last, 91.

Thus the efficiency varies from 67 per cent. to 91 per cent.

An average of the efficiencies of the survey work and the office work shows that one company received 76 per cent.; another, 66; another, 85; and the fourth, 57.

Thus the efficiencies range from 85 per cent. to 57 per cent.

Another line of examination disclosed that the total tons of coal produced per hour per man for the full Mining Engineering Department, was 40 tons, 43 tons, 69 tons, and 77 tons, respectively, for the four companies under consideration.

First-Aid Contest

The Woodward and Pettebone first-aid corps will hold their annual contest on August 15. The interest is especially keen this year, and the following prizes are offered: First prize, $50; second, $25; third, $15; fourth, $10; and a safety lamp for the captain of each winning team. The above are for adult teams. For teams composed of members under 17 years of age, the following prizes are offered: First prize, $15; second, $10; third, $5.

Anthracite Shipments in June, 1914

Shipments of anthracite in June amounted to 285,811 tons more than in May, 1913, and only 35,799 tons less than the record tonnage for the month made in 1911. In June 6,281,553 tons were shipped; in May, 1913, 5,995,742 tons; and in May, 1911, 6,317,352 tons.

The Lehigh Valley handled 1,249,218 tons; the Philadelphia & Reading, 1,202,679 tons; and the Lackawanna 901,596 tons. The Central Railroad of New Jersey carried 782,889 tons; the Erie, 702,892 tons; the Delaware & Hudson, 663,648 tons; the Pennsylvania, 579,869 tons; and the New York, Ontario & Western, 198,762 tons. —*P. & B.*

Mining Institute Meetings

The West Virginia, and the Kentucky Mining Institutes, The Coal Mining Institute of America, and the Mine Inspectors' Institute

Written for The Colliery Engineer

WEST VIRGINIA MINING INSTITUTE

THE thirteenth semiannual meeting of the West Virginia Mining Institute was held at Cumberland, Md., June 2, 3, 4, and 5. The opening session was held on the morning of June 2, when addresses of welcome were made by Dr. Thomas W. Koon, Mayor of Cumberland, and Thomas Footer, president of the Cumberland Chamber of Commerce. After the responses, President Neil Robinson delivered his presidential address in which he complimented THE COLLIERY ENGINEER on the good work it had done in the past in helping to advance the technology of the coal mining industry. He was followed by R. A. Walter, chief engineer of the Consolidation Coal Co., Frostburg, Md. Mr. Walter's address was extremely interesting and of such value that it was printed in full by the Cumberland *Daily News*.

Mr. Clarence Hall, consulting chemist, of Pittsburg, Pa., intended to read a paper on the "Explosives Used in Coal Mining," business intervened, however, and he was unable to attend.

In the evening Mr. P. J. Brennan, superintendent of the Davis Coal and Coke Co., Thomas, W. Va., read a paper on the "Necessary Training for Mine Officials." Among other things he stated that "New mines are being opened, mostly shaft mines of various depths, consequently they are more difficult to mine safely than the older mines; that many companies are remodeling old plants, tearing out obsolete equipment and replacing it with the most improved and efficient appliances and machinery obtainable. Yet, with all, there is one very important element in the operation of a mine that is being overlooked, that is the training and preparing of the men who are to be the official staff upon whom will depend, to a considerable extent, the safety of other employes and the success of the operation." He then stated what mine officials should know.

This paper was followed by the Question Box session. Fortunately there was no stenographer present so that it was "some session." The questions which caused the free-for-all discussions were:

1. Which is the safer mine—one that is fiery, so recognized and guarded by the use of safety lamps, permissible explosives, compressed air as a motive power, paid shot firers, effective methods of treating dust, rigid discipline, etc.—or a mine where gas is found occasionally at any part of the mine, or continuously at certain sections of the mine, and operated as a mine of lesser risk, preventive measures being used in proportion to the believed danger?

2. Should ventilation be based on a stated number of cubic feet per man and animal underground, as at present required by the mining laws, or should it in addition, be based on the quantity of methane and carbon dioxide shown by analyses of return air-currents?

3. Which is the proper method of setting a post—the small end up or the large end up?

Readers of THE COLLIERY ENGINEER are requested to express their views on these three questions.

Dean Jones, of the University of West Virginia, stated that Secretary Zern's Question Box was a decided success.

The evening was devoted to social pleasure and the moving picture show of the Safety First precautions taken at Gary, W. Va.

The third session was opened by George E. Sylvester, Chief Mine Inspector of Tennessee, who read a paper on "Organization and Prep-

aration for Mine Rescue Work." He stated that wherever bituminous coal is mined there seems to be no way of entirely eliminating mine explosions. It is probable, however, that with the modern practice of mining with the increased use of machinery and the more rapid development, with more extensive and deeper mines, the danger of individual accidents and explosions is increased; and while doing everything possible to prevent accidents, we must admit that the explosions and mine fires remain a possibility, although their occurrence may be rare; so we should be prepared to handle an emergency when it comes.

Mr. Sylvester was followed by Mr. A. W. Hesse, assistant chief engineer of the Consolidation Coal Co., Fairmont, W. Va. His paper will be found in another column of this issue.

Dr. Robert Douglass Roller, Jr., of Eccles, W. Va., read a paper on "Sanitation and Simple Ways of Making It Effective." His paper was discussed by several operators present and its latitude was widely increased by various special interjections, such as, what will be the effect of prohibition, which goes into effect on July 1 in West Virginia, on the health of miners, or whether "it is better to accept what we have than partake of what we know not of." Some of the remarks on this new law, especially by men who never drink, would lead one to suspect that they were very doubtful as to the feasibility of carrying it out successfully.

Mr. Neil Robinson told of the work he was doing at the LaFollette plant in Tennessee, in the way of sanitation and to decrease the number of hookworm patients. This led to a discussion of the water supply and next to the disposal of the wash water. When operators turn to "Health First" and "Safety First," the miner's lot is indeed fortunate.

In the evening George S. Rice, chief mining engineer of the United States Bureau of Mines, of Pittsburg, Pa., read a paper on the "Recent Experiments on Coal Dusts." The paper treated on the danger of explosions in mines of ordinary coal dust and the methods experimented with for preventing dust explosions.

Following the reading and discussion of the paper, Mr. Rice gave an illustrated lecture on mine accidents, their causes and how to prevent them. We believe that on the whole the paper of Mr. Rice's, which appears in this issue of The Colliery Engineer, is better than the one he delivered in Cumberland.

Following the illustrated lecture of Mr. Rice, the Editor of The Colliery Engineer, which was stated in the Cumberland *Daily News* to be the official organ of the Pennsylvania Bureau of Mines, read a paper on the "Adaptability of West Virginia Coals for By-Product Coking." According to the paper quoted "he plainly outlined the superior quality of the coal in the Fairmont, Georges Creek, and Connellsville regions for coking purposes. He also exhibited a sample of coke from the southern Illinois coal field and demonstrated by drawings the difference between that particular product and the product of the West Virginia, Pennsylvania, and Maryland coal and coke regions." As Mr. J. A. Cunningham, mining engineer, Ashland, Ky., remarked "He must be some drawer."

A. D. Macfarlane, chief engineer, LaFollette Coal, Iron and Railway Co., LaFollette, Tenn., read a paper on "An Endless-Rope System for an Inclined Plane." This paper referred to a long gravity plane at LaFollette over which trips of five cars ran, making it possible to ship from the mine more than 1,000 tons daily. As the plane was on a curve, and the pitch of the plane was uneven, considerable discussion was evoked on planes in general.

Fig 1. No. 12 Mine, Visited by West Virginia Mining Institute

In the evening the Institute held a banquet at the B. & O. Y. M. C. A. Secretary Montignani sang several Scotch songs in which the audience joined. Mr. Neil Robinson, who responded to the very kind words of welcome from Mr. A. Taylor Smith, attorney, of Cumberland, stated "that the existence of coal in the Georges Creek basin seems to have been known in 1782, and it was mined near Frostburg, in 1804. In about 1830 and ten years later some shipments were made in barges on the Potomac River, and in 1842 the Baltimore & Ohio Railroad began the movement by rail. In 1850 the Chesapeake & Ohio Canal was completed and in the fall of that year Maryland marketed 317,460 tons."

On June 4 the day was spent in visiting points of interest about Cumberland and Georges Creek. The trip was made from Cumberland to Frostburg by trolley and from Frostburg over to the Piedmont District to the No. 12 mine of the Consolidation Coal Co., the tipple of which is shown in Fig. 1. This shaft mine 154 feet deep, is one which the Consolidation Coal Co. have recently acquired. It was formerly known as the Old Borden shaft and was allowed to remain idle for 29 years in which time it filled with water. The engineers of the Consolidation company decided that a better way to dispose of the water in this mine was to drive a tunnel on the coal bed 1 mile long and by this means unwater the mine and keep it unwatered rather than by making use of pumps. This plan has been very successful. When the mine was entered it was found that the timbers at the foot of the shaft were in a first class state of preservation after 29 years. They are still in good shape. The hoisting engine was constructed in 1872 by G. W. Snyder, of Pottsville, Pa. It is a two-cylinder first-motion engine with cylinders 48 in. × 20 in., and although it remained idle many year, it is in perfect running order and works as well as a new engine.

Georges Creek bed is about 15 feet thick and because of the tender nature of the upper 3 feet, it is left for roof at a parting. This seems to hold up well although considerable timber is needed in the rooms. These timbers are from 10 to 12 feet long. The visitors were permitted to follow the system of pillar robbing adopted and also the mining. One peculiar feature in this coal bed is the lack of cleatage. There are horizontal cleavage planes, but the ordinary butt and face cleatage found in the same bed further west is lacking.

Those who attended this meeting will long remember it as one of the most interesting conventions of the Institute. The next meeting will probably be held at Huntington, W. Va.

KENTUCKY MINING INSTITUTE

The third annual meeting of the Kentucky Mining Institute was called to order in the Mining Engineering Building of the University of Kentucky by F. D. Rash, vice-president of the St. Bernard Coal Co., President of the Institute, W. L. Moss being absent. B. R. Hutchcraft, vice-president of the Institute, then took the chair and called on Major R. U. Patterson, Medical Corps U. S. A., and chairman of the National First-Aid Committee of the American Red Cross Society, for an address on the history and purposes of the Red Cross. The Major's remarks were exceedingly interesting, as they gave the history of the Red Cross Society from its inception to the present day. He was followed by I. P. Tashof, of the University, who talked on "Mine Safety in the Lake Superior Copper District," and the precautions taken to avoid accidents. He explained the conditions prevailing at the deepest mines in the world and how much was being done to educate the men to observe the rules and consider safety paramount to all other matters. Out of every 300 employes in these mines 100 are natives and 200 Cornish, Finnish, Croatian, Italians, and Russian. These miners are some of the finest specimens of physical culture to be found in America in mines or anywhere else.

At noon the delegates adjourned to the armory to partake of a buffet luncheon prepared by Miss Ruby Tucker and others of the Department of Domestic Science of the State University whose names unfortunately are disremembered there were so many of them; however, they could make pie, sandwiches, and white fudge. After this enjoyable luncheon Mr. Everett Drennen, manager of Elkhorn Division of the Consolidation Coal Co., read a paper on "Mine Motors" that was exceedingly instructive and interesting, an abstract of which will be printed later. Mr. C. W. Strickland took for his subject "Some Other Difficulties," in which he verbally portrayed what new coal companies starting in Kentucky were compelled to bump against and the necessity of having sufficient local acquaintance with the natives to overcome the difficulties, by means of extra capital. Some of his remarks provoked laughter and most of them smiles that clearly indicated their wearers possessed at least a working knowledge of the difficulties.

W. H. Cunningham, mining engineer, of Ashland, and secretary of the Kentucky Mine Owners' Association, talked on the new "Workmen's Compensation Law" which he was instrumental in bringing to a conclusion. This act provides a money compensation for employes who may become injured or the dependents of those killed in the course of their employment. The act creates a board of commissioners composed of the Attorney General, Commissioner of Insurance, and the Commissioner of Agriculture, Labor, and Statstics, of the Commonwealth of Kentucky, which shall investigate accidents and make awards. The commissioners can issue subpoenas and compel witnesses to attend their meetings.

All persons, firms, and corporations employing six or more persons for carrying on industries are subject to the act; with provisos that eliminate agriculturists.

The board has power to reclassify and create additional classifications according to their degree of risk, and to fix the premiums of each class of employers sufficiently large to provide an adequate fund for the compensation provided for in the act, and to create a surplus to guarantee a workmen's compensation fund from year to year; provided the rates so fixed shall not exceed the maximum of $1.25 on each $100 of the payroll of each employer in any class for the first year after this act takes effect, but the board may increase the rate if deemed necessary on the first day of July or January in any year. Every employer must furnish the board with information required by it to carry out the purpose of this act.

The treasurer of the state is custodian of the fund created, but the board has power to invest any surplus or reserve of the fund in United States or Kentucky bonds. Employers subject to this act shall not be liable for damages at common law, and it is lawful for any employe to contract with any employer who is subject to this act to receive compensation provided by the act; and such contract shall be presumed to have been made in every case where an employer has elected to pay into the Workmen's Compensation Fund, if the employe shall continue to work for the employer after notices are posted of such election by the employer. Benefits of the act are $100 for hospital and medical services; $75 for funeral expenses; temporary disability, a maximum of $12 and a minimum of $5 weekly, but in no case is compensation to continue more than 6 years or to exceed $3,750. In case of permanent or total disability the award is 50 per cent. of the person's wages. In case injury causes death within 2 years the dependents receive 50 per cent. of the average weekly wages for 6 years. Employers may carry liability insurance, and may elect not to pay into the liability fund, in which case they are subject to common law procedure.

Mr. Cunningham made remarks on almost every section of the act explaining the why and the wherefore of the enactment.

Prof. C. J. Norwood made some remarks classifying the new law as a good one. A banquet was held at Hotel Phoenix which was also a successful affair. The speakers were J. G. Cramer, Hon. H. S. Barker, Major R. U. Patterson, F. D. Rash, ex-president of the Institute, and Van H. Manning, Esq.

The second annual state wide first-aid competition was part of the program of the Institute meeting, and May 9 was entirely devoted to this affair, with the exception of the annual business meeting in the morning. At this meeting H. La Viers, of Paintsville, was elected president for the ensuing year; Ivan P. Tashoff, of Lexington, secretary-treasurer; vice-presidents, W. C. Tucker, Benham; L. B. Abbott, Jenkins; W. S. Wells, Prestonburg; J. E. Butler, Stearns; B. R. Hutchcraft, Lexington; W. C. Taylor, Greenville; W. E. Jenkins, Sturgis. A report of the secretary-treasurer, T. J. Barr, showed a deficit which will be raised by the assessment of the members. The deficit was due to the expenses connected with the transportation and installation of the United States Bureau of Mines long explosion tube used as an ocular demonstration of the explosion of coal dust by blown-out powder shots, and the safety of permissible explosives compared with black powder. The moving pictures which the United States Bureau of Mines obtained from the United States Coal and Coke Co. at Gary, W. Va., and elsewhere, were exhibited as a means of illustrating safety devices adopted by coal companies in the United States to prevent accidents, and to show the right and wrong way of doing things in and about mines.

At 1:30 P. M. the different first-aid corps assembled, and headed by the cadet band marched to Stolls field, where the exercises were held. The members of the Institute marched behind the corps until they lined into an imposing parade, that seemed satisfactory to the moving picture man. The Continental Coal Corporation brought its band, and the Stearns Coal and Lumber Co. would have brought its band had the members' new suits arrived in time, however, Mr. Stearns expects his band will be at the next meeting. Mr. E. B. Sutton, of the Bureau of Mines, and Major R. U. Patterson, of the Red Cross Society, had charge of the tube and first-aid events which were witnessed by a large number of persons. The judges were Doctors J. W. Pryor, B. F. Van Meter, L. C. Redmon, and J. H. Wilson. The explosions in the 100-foot long tube acted as planned, but on account of the helmets not arriving there was no attempt made to do any recovery work. Later for the benefit of the picture man the Barthell team of the Stearns Coal and Lumber Co. went into the tube, brought a man out on a stretcher and resuscitated him with a lung motor.

The tie for the 1913 First Prize, the Goodman Mfg. Co.'s silver cup, between the Continental Coal Corporation's Barker team and the Wisconsin Steel Co.'s Benham team, was decided in favor of the Benham team. All the first-aid teams showed improvement over their work of the previous year, and these trips to Lexington and Knoxville, given them by the operators, are broadening the men's ideas and increasing their efficiency and loyalty to an extent that the employers little realize; and from remarks made by men from various teams there seems to be no question but that these outings will prove a big asset to the coal companies.

Every team won a prize. The Continental Coal Corporation's No. 1 team captured the State University Trophy Cup and Red Cross medals. The W. G. Duncan Coal Co.'s Graham team won the Sanchez Challenge Cup and American Mine Safety Association medals.

Jeffrey Mfg. Co., of Columbus, Ohio, offered $60 in gold as a prize which was divided by the Barthell team of the Stearns Coal and Lumber Co. and the Benham team of the Wisconsin Steel Co. Mr. Stearns had previously informed his teams that if they won a money prize he would add as much more, the members of this team are therefore good for $10 apiece.

The Fairmont Machine Co., of Fairmont, W. Va., which was represented at the meet by S. M. Casterline, gave vest-pocket cameras as prizes to the Skibo team of the Duncan Coal Co.

The Ohio Brass Co. offered as a prize $15 in gold which was captured by the Barker team of the Continental Coal Co.

The Bryan-Hunt Co. of Lexington donated $12 as a prize which Jenkins No. 1 team of the Consolidation Co. won. The Standard Oil

Co., of Kentucky, offered a three-burner oil stove as a prize, which was won by the Van Lear team of the Consolidation Coal Co. The Banks Supply Co., of Huntington, donated six carbide lamps, which the Stearns team, of the Stearns Coal and Lumber Co., received. The Whittaker Paper Co., of Cincinnati, gave team No. 1 of the St. Bernard Coal Co., of Earlington, an order for $20 in merchandise.

Eight nickelplated Baldwin carbide lamps were given to the Whorley team of the Stearns Coal and Lumber Co., by the A. & B. Co., of Knoxville, Tenn. W. R. Milward, Esq., Lexington, Ky., gave $5 to the Yamacraw team of the Stearns Coal and Lumber Co., and the Goodyear Raincoat Co. presented a coat to the No. 2 team of the Continental Coal Corporation.

Yearly subscriptions to the *Lexington Leader* and to the *Lexington Herald* were won by the Jenkins team No. 2 of the Consolidation Coal Co., and the Justrite Mfg. Co., of Van Buren Street, Chicago, Ill., gave a variety of polished acetylene lamps to the same team.

The Miller Supply Co., of Huntington, W. Va., gave engraved Justrite acetylene lamps to Continental team No. 1 of the Middlesboro District, Graham and Luzerne teams of the W. G. Duncan Co., of the Western Kentucky District, Jenkins No. 1 team of the Eastern Kentucky District, and Barthell team of the Stearns Co. in the Southern, or Q. and C. District.

The recorders were R. D. Quickel and D. W. Smith; Field men, N. G. Alford (Aborigine), Earlington, Ky.; C. G. Evans, E. M. Jenkins, Ky.; Ray B. Moss, Wilhoit, Ky.

President Henry S. Barker, of the University, and Major R. U. Patterson awarded the prizes.

While the first-aid events were in progress the large audience was entertained by the Interscholastic Athletic Association of Kentucky, which held its meet at the same time and place.

The Kentucky Mining Institute has been a very active body from its inception, and furnishes plenty of mental and physical food for the members attending. Last year it gave a cadet parade and had a baseball game scheduled, in addition to the first-aid meet, which seems to have become a fixture of the annual meeting.

MINE INSPECTORS' INSTITUTE OF AMERICA

The seventh annual meeting of the Mine Inspectors' Institute of America was held in Pittsburg, June 9 to 12, inclusive, with delegates from nearly every coal mining state of any consequence.

The meetings were held on the twenty-fifth floor of the Oliver Building. City Solicitor Charles A. O'Brien welcomed the institute in behalf of Mayor Armstrong, as did President D. P. Black of the Chamber of Commerce for the business men of the city.

The president of the institute, D. J. Roderick, of Hazleton, Pa., in his address referred to the several serious mine disasters since the preceding meeting in Birmingham, Ala. He said that Europeans give little thought to the production and area of this country when they hear of the great catastrophes, and unless something more is done to eliminate accidents the people of the world will believe that the United States cares little for the lives of its workmen.

R. H. Beddow, state mine inspector of New Mexico, described the Dawson disaster. He attributed the cause to the firing of a careless shot at a daylight hour when all the men were in the mines, a direct violation of the law.

John Dunlop, of Peoria, Ill., was unable to be present to read his paper on "Booster Fans," and it was read by the secretary, J. W. Paul. P. J. Moore, of Carbondale, Pa., read a paper on "First Aid to the Uninjured," and I. G. Roby, of Uniontown, Pa., read a paper on "The Value of Organized Effort in Increasing Safety in Mines." George S. Rice, of the United States Bureau of Mines, made an address on "Some Recent Experiments Pertaining to the Control of Mine Explosions." The meetings were interspersed with a boat ride up the Monongahela River, an automobile ride through the city, a banquet at the Monongahela House, and a trip to the testing station of the Bureau of Mines and to the Experimental mine at Bruceton, Pa.

At the experimental mine, the purpose of the explosion test was to determine the efficiency of various forms of rock dust barriers in stopping the propagation of an explosion and the influence of a strong ventilating current in two parallel entries in which the coal dust loading is symmetrical. An igniting shot of 4 pounds of black powder was used and two kinds of stone dust barriers were placed along the entries, the Taffanel and the Rice. The explosion was not nearly as violent as at some previous tests and no sign of flame was visible.

Before the institute adjourned, John Dunlop, of Illinois, was elected president and St. Louis, Mo., chosen for the 1915 meeting.

COAL MINING INSTITUTE OF AMERICA

The summer meeting of the Institute was held June 16 and 17, at Monongahela, Pa., with but a small attendance. Mayor Isler welcomed the Institute and told many stories and anecdotes of early coal mining in that vicinity. Henry Louttit, of Monongahela, an ex-mine inspector, and William Seddon, of Brownsville, made impromptu addresses, giving reminiscences of mining in and about the Monongahela River valley. Mr. Louttit vigorously denounced the "hurry" that is in evidence about all the mines and said that many accidents are due to that cause alone.

William Lauder, of the Pittsburg Coal Co., read an interesting paper on "Method of Timbering and the Quality of Timber." He said that along haulage roads the props should be set in the coal so as to be flush with the rib. Short collars, he asserted, added strength, and the timbers should be cut in the winter

months in order to get the maximum life in the mines.

William Seddon, in a paper on "Method of Timbering with Reference to Overlying Strata," said: "A universal system of timbering is absurd, firm material naturally holding up better than loose cover. The size of the posts can seldom be determined, for they must conform to natural laws."

H. I. Smith, of the United States Bureau of Mines, read the concluding paper of the first day on "Possible Substitutes for Mine Posts." He gave a sketch of the work done by state and national forest reserves in preserving trees and said in regard to mine posts: "The best results come from using soft caps which allow the posts to set in them. Hydraulic filling, pack walls, piers of gob rock, masonry, and concrete, and steel timbering, are all possible substitutes."

In the discussion which followed, Dr. W. R. Crane, of Pennsylvania State College, in speaking of the cogs filled with gob rock, commonly seen in anthracite mines, said that recent tests at Lehigh University showed that cogs of concrete filling need be of but one-third the size now used.

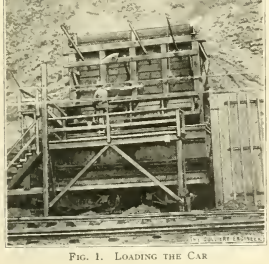


Fig. 1. Loading the Car

In the evening, S. A Taylor, consulting mining engineer of Pittsburg, gave an illustrated lecture on "The Advancement in Bituminous Mining During the Last Forty Years."

The second day's session was opened with a talk by A. J. Cameron, general manager of the Westmoreland Coal Co., of Irwin, Pa. Mr. Cameron took as his subject "Legislation Against Mining Machines and Electricity in Mines." He condemned the movement to bring about such laws and pointed out the fact that in 1912 but one machine miner was killed in pillar mining in Pennsylvania. He said it is just as consistent to make farmers stop using mowing machines and go back to the old scythe. The Department of Mines statistics of 1912 as compared to those of 1899 show a reduction of accidents per 1,000 tons of coal produced.

New Method of Handling Rock

At the Bear Valley colliery, of the Philadelphia & Reading Coal and Iron Co., near Shamokin, Pa., a novel method of handling the breaker refuse has been adopted.

Instead of three long conveyer lines, but one is used. The rock, etc., runs down the bank on a sheet-iron chute into a bin. A 20-ton car (Fig. 1) electrically operated by an overhead trolley, is run below the bin and filled. The refuse is taken out in the country a mile from the colliery and dumped along the hillside as shown in Fig. 2. This one car is operated by one man who does all the work. It eliminates 10 men by doing away with two scraper lines. The car is made by the Atlas Car and Foundry Co., and easily handles the refuse from this anthracite mine which produces 1,000 tons per day.

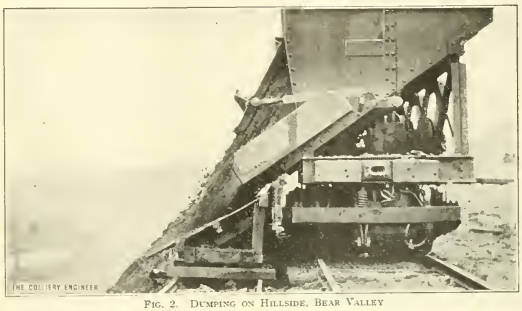


Fig. 2. Dumping on Hillside, Bear Valley

A Strange Accident

A strange accident recently occurred at Ormonde colliery, Derbyshire, England, in which an official had his foot blown off by a high explosive.

It appears that the detonator ignited the explosive and the detonating pressure resulted in the explosive burning in the hole until sufficient force was generated to blow out the tamping. The official noticing the glare of something burning on the floor, went to the scene, put his foot upon it and it exploded. Upon inspection it was found that the coal was intact, only the tamping having been blown out by the shot. The unconsumed part of the explosive had fallen about 5 feet from the face, where it lay burning when seen by the official.

A prominent English mine manager said the only feasible explanation was, that the detonator had lost its strength. It seemed to him that mine managers should think seriously before they allowed the men to go to the place straightway after an electric misfire, and that they should stay away for at least 20 minutes.

Important and Deserved Promotions

Under date of June 8, W. J. Richards, President and General Manager of the Philadelphia &

Edward E. Kaercher, Gen'l Supt.

Reading Coal and Iron Co., announced the promotion of Edward E. Kaercher, Division Superintendent of the Tremont Division, to the position of General Superintendent of the Tremont, Mahanoy, and Shenandoah divisions; the promotion of George B. Hadesty, Division Superintendent of the St. Clair Division, to the position of General Superintendent of the St. Clair, Shamokin, and Ashland-Gilberton divisions; and the promotion of John F. Bevan, Division Engineer at Shamokin, Pa., to be Mining Engineer for the St. Clair, Shamokin, and Ashland-Gilberton divisions. Under the same date, John F. Bevan, Mining Engineer, announced the promotion of Fred C. Caldwell from the position of transitman to that of Division Engineer for the Shamokin Division.

The first three promotions are to newly created offices, and the idea of two general superintendents is to give the extensive mining operations of the company closer expert supervision than would be possible if there was but one. The operations of the Philadelphia & Reading Coal and Iron Co., comprising over two score extensive collieries, extend in the Middle Anthracite Field, from the western limit at Trevorton to the eastern limit of the field at Mahanoy City, including the Shenandoah Valley, a distance of about 35 miles, and in the Southern Field from near the western limit to Tamaqua, a distance practically the same.

Previous to his promotion to the presidency, Mr. W. J. Richards, as Vice-President and General Manager, personally directed the entire operation work, assisted by a competent corps of division superintendents, among whom were Messrs. Kaercher and Hadesty. These two, owing to their ability, capacity for work, and their success in handling difficult problems, were the natural choice of Mr. Richards for the new positions.

In the appointment of Mr. Bevan to the position of Mining Engineer, the object was to relieve Messrs. John R. Hoffman and George S. Clemens, mining engineers, of the two great sections of the company's property, of duties that had become too great for two men to handle. The position of mining engineer in the P. & R. C. and I. Co.'s organization is equivalent to that of Chief Engineer in other companies; the only difference being that the Coal and Iron Co. has three chief engineers, each of whom directs the engineering work in specific territories, and all three of whom are available for general consultation.

John F. Bevan,
Mining Engineer Phila. & Reading Coal and Iron Co.

Messrs. Hadesty and Kaercher both began their mining experiences in the engineering department of the

George B. Hadesty, Gen'l Supt.

P. & R. C. and I. Co., the former in 1883, and the latter in 1879. In 1898, Mr. Hadesty resigned to accept the position of Division Engineer for the Lehigh & Wilkes-Barre Coal Co., at Audenreid, Pa., where he was later promoted to the division superintendency. In September, 1905, he returned to the service of the P. & R. C. and I. Co. as Division Superintendent of the St. Clair Division.

Mr. Kaercher, after 8 years' service in the engineering department of the P. & R. C. and I. Co. resigned in 1887 to accept a position on the force of the Second Geological Survey of Pennsylvania. Some 15 months later he returned to the service of the Coal and Iron Co., as Assistant Engineer at Tremont, and was promoted to the position of Division Superintendent of the Tremont Division on August 1, 1904.

Mr. Bevan's whole mining experience has been gained in the service of the company of which he is now one of the chief mining engineers. He entered the service of the company as a chainman February 1, 1890. Eight years later he was made a transitman, and on May 1,

1904, he was made division engineer of the Shamokin Division.

One of Mr. Bevan's first official acts was the promotion of Fred C. Caldwell, assistant engineer, to the position of Division Engineer of the Shamokin Division. Mr. Caldwell is also a man whose mining experience was gained in the service of the P. & R. C. and I. Co.

Barlow Medal

The suggestion has been made that something should be done to keep Dr. A. E. Barlow's memory green so long as the Canadian Mining Institute shall continue. To this end a provisional committee has been organized to secure contributions for a "Barlow Memorial Fund." Every member of the Institute is invited to contribute to this fund. Subscriptions from $1 upwards will be welcome. The form the memorial will take has not yet been decided definitely; but it is suggested that a sum of money be raised and invested in trust funds to yield an annual income sufficient for the purchase of a gold medal to be known as the "Barlow Memorial Medal," and awarded as a prize for the most valuable paper contributed to the Transactions of the Institute in any one year. Doctor Barlow and his wife went down with the "Empress of Ireland." H. Mortimer-Lamb is secretary of the Institute.

Output of Anthracite in 1913

According to the figures reported to the Topographic and Geologic Survey, working in cooperation with the United States Geological Survey, the production of anthracite in 1913 was 6,395,825 gross tons in excess of the output of 1912, an increase of 8½ per cent. Part of this increase is undoubtedly due to the closing of the mines in 1912 pending the settlement of the mining scale, yet it is almost 1,000,000 gross tons in excess of the production of 1911, which was the previous high record year. This marked increase again brings up the question of the ultimate maximum output of anthracite. While it is well known that the output of bituminous coal doubles each decade, yet the increase in the output of Pennsylvania anthracite shows no such change. This, at least in great part, is due to anthracite being no longer a manufacturing fuel, but essentially a domestic one. It has been thought by some that the present output will not be greatly increased; others seem to think that 100,000,000 gross tons per year will be the maximum amount ever mined. It is evident that, so far as can now be seen, the increase will be small from year to year, the ever increasing cost of production being one of the factors which will retard the growth of the output.

There was an increase in the total selling price at the mines in 1913 of $17,558,501, as compared with the preceding year, the average price per gross ton being $2.38 as compared with $2.36 for 1912.

The average selling price at the mines for several years is shown by the following table:

Year	Average Price Per Gross Ton
1903	$2.28
1908	2.43
1909	2.06
1910	2.12
1911	2.17
1912	2.36
1913	2.38

The average cost of mining anthracite in 1909, as reported by the Census Bureau was $1.93 per ton, exclusive of any charges for depreciation, amortization, or interest. On the same basis, with the increase in the mining rate as provided in the agreement of May 20, 1912, the cost would be, according to Mr. E. W. Parker, of the United States Geological Survey, $2.07 per ton. This would mean in 1913 that the average selling price was 31 cents per gross ton above the mining rate, from which must be deducted the items of depreciation, amortization, interest, and the increase in all items of expense not covered by the agreement of May 20, 1912.

The following table gives the total production in each of the several counties for the years 1912 and 1913:

PRODUCTION IN GROSS TONS OF ANTHRACITE COAL IN 1912 AND 1913 BY COUNTIES

County	1912	1913
Carbon	2,568,305	3,066,314
Columbia	1,079,866	1,078,481
Dauphin	843,841	946,670
Lackawanna	19,283,814	20,240,490
Luzerne	28,289,879	31,539,579
Northumberland	6,020,440	6,261,502
Schuylkill	16,038,307	17,328,666
Sullivan	579,673	1,123,192
Susquehanna and Wayne	532,808	
River dredges	85,722	133,986
Total	75,322,855	$1,718,680
Total value	$177,622,626	$195,181,127

Hookworm in the Pocahontas Field

Dr. S. L. Jepson, of the State Board of Health, West Virginia, repudiates the alleged interview with him printed in the *Pittsburg Post*, widely circulated in West Virginia newspapers, to the effect that representatives of his organization had found the hookworm to be epidemic in the Pocahontas coal fields.

When the letter of Doctor Stiles, the noted hookworm expert, claiming that the disease was prevalent in the southern part of the state, was made public, Governor Hatfield, the coal operators in that section, and the members of the State Board of Health indignantly denied the expert's assertions. Then immediate steps were taken to prove that the statements were untrue and a bacteriologist from the State University was sent to the Pocahontas region. Doctor Jepson states there are no evidences that the cases of hookworm there are other than sporadic. Governor Hatfield and other state officials are indignant that the papers of the state should have been unconsciously used as mediums to circulate the false report. Doctor Jepson says that no coal field is wholly free from this disease and that the West Virginia fields are in better condition than most regions where coal is mined.

The state of Pennsylvania celebrates two arbor days each year —one for spring planting and one for the fall—in April and October, respectively.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Oil in Air Receivers

Editor The Colliery Engineer:

Sir:—Will you please place the following in your columns for some reader to answer.

How does oily waste accumulate in an air receiver, and what steps should be taken to prevent its accumulation? If an air receiver with an accumulation of oily waste inside is liable to take fire if allowed to get hot, what steps should be taken to prevent its getting hot? How can cylinder oil be prevented from accumulating on the top of water in an air receiver? I read that "When the water is drawn off the oil will be deposited on the inner surfaces of the receiver and will be in suitable condition to evaporate and cause an explosion of great violence." We blow out our air receiver every time the water gauge shows a certain accumulation, should we do it oftener?

Compressor Engineer

Some Reflections

Editor The Colliery Engineer:

Sir:—Subjects for scientific discussion appear to be as much influenced by the popular fancy and the desire for change as are questions referring to the tightness of women's skirts, to the color of men's ties, or to any of those thousand and one fads and vagaries of fashion that take up the woman's page in a Sunday supplement. And the discussion yields about the same results in the one case as in the other. Booster fans, mine fires, etc., have been discoursed upon *ad nauseam*, and the important decisions have been reached that booster fans are to be recommended in some cases and condemned in others, and that as mine fires differ in origin, location, etc., each fire must be treated differently. When fans and fires waned in popularity, although the last word has by no means been said about either, carbon monoxide came up for a few choice remarks. And what will be done to this poor gas before we are through with it will be "a plenty."

I am not condemning popular discussion. There is nothing like it for bringing out the truth, for learning hitherto unknown facts, for hearing strange experiences, and for making new friends among coworkers in the same field. The trouble is not in discussion, but in that the results of discussion are not summarized and presented in such a way as to be of the most value to those who either have not had the time or opportunity to read the testimony in the case, or who, having read it, are not able to separate the wheat from the chaff. It is an unusually able man who, after reading the opinions of twenty or thirty others upon a certain subject, is broad gauged enough to forget that his own experience and prejudices are not the most important things in this world, and thus place himself in the mental attitude necessary to render an absolutely unbiased and impartial decision in any matter. Very few of us have this ability and many more of us are too busy wresting a hard earned living from a grasping corporation to afford the time. If the editor would only play the role of judge charging jury and would sum up the evidence, the average reader would rise up and call him blessed.

None of us care very much about the opinions of Bill Johnson or Harry Smith upon purely theoretical matters, nor do we greatly care for their views upon the way to meet contingencies that they themselves have never met, because each one of us has an opinion or two of his own and is probably just as good at guessing as either of them. But we are all vitally interested in learning how the countless Johnsons and Smiths improved the ventilation or fought a fire, because any one of us may have to do either one of these things at any time. We all want to hear their experiences, not their guesses; we want to hear *what* the conditions were at their mine, *why* something had to be done, *how* it was done, and *what* were the results; but above all, when the testimony is all in, we want some one to take this mass of often contradictory opinions and apparently irreconcilable facts and digest them and whip them into such a shape that you and I and other busy men may be able to sanely and safely use them should a time come for us to do so. Perhaps this is not altogether possible, but it seems to me that you and I are going to have many a mental belly-ache until most of these discussions are summarized and boiled down to a maximum of fact and a minimum of fancy and prejudice.

There are a lot of mighty mean people in this vale of tears. Here you and I and all the rest of us for many years past have been content in the belief that methane burned with insufficient air yields carbon monoxide. And now some iconoclast comes along and says it does no such thing and that it makes olefiant gas. The books are being quoted, the authorities are being marshaled, and those who know nothing about it are rendering first-aid to the ignorant by telling us what Bill said and Charlie guessed and what might happen if things were different and "just like what they were when I was a boy." There is nothing left for us but to take to the intellectual tall timber and when the battle of the

giants is over to come down, put on our helmets, and accompanied by the humble but omniscient dickie bird which obligingly falls off its perch at the first approach of monoxide, grope through the mental afterdamp and find out what all the noise is about.

I'm strong for the Dutch or, to put it more elegantly, I am a great admirer of the German character. In matters scientific the German is the judge and the court of last resort. The German does not guess, he knows; and what he does not know he finds out, if it takes a lifetime to do it. But when two Germans disagree on the same point, what is the average man to do? The Golden Rule of the Chinese: "Do nothing lest ye do evil," is probably the course of action most of us will follow. The cause of the war appears to be in the discrepant statements of Doctor Brunk, of Freiberg, and Doctor Brookman, of Bochum, both of them to the best of my knowledge and belief eminently respectable Germans who pay their grocer's bills, go to church on Sunday, and consume innumerable seidles of Wurtzberger during their waking hours. Doctor Brunk says that in too little air for complete combustion methane burns to carbon monoxide just as does coal under the same conditions; Doctor Brookman says that this is not true, but that in a deficiency of air methane burns to ethylene. And there you have it. When doctors disagree, the patient has a reasonable chance to recover, so perhaps this may all work out to the common good by inducing some one to make a really authoritative series of tests. In the meanwhile would it not be a good plan to compare the conditions under which the experiments of the past have been made? If the conditions of experiment were the same the results obtained should be identical; if the conditions were not the same, then there is a good reason why results should not agree. A man of Doctor Brunk's standing does not say that monoxide is formed by burning methane in a deficiency of oxygen just because he read it in a book or was told so, nor does a man of the attainments of Doctor Brookman make the diametrically opposite statement and a statement at variance with generally accepted views without a very good reason for doing so. As good Americans let us leave it to our own Bureau of Mines which has the men, the means, and I believe, the inclination to conduct the necessary experiments.

It is a matter of general knowledge that the pestiferous little English sparrow is just as useful as a means of detecting small amounts of monoxide in the mine air as the more comely canary. He is far more numerous and much less costly than the canary, and no one wants him around or will miss him when he is gone. Now that modern innovations have reduced him to a diet of gasoline, the sparrow may be readily caught by scattering crumbs of bread or small grain soaked in whiskey. However, this method of trapping sparrows is not everywhere possible for reasons best known to the legislatures of Kansas and similar states.

One of the best posted men on all phases of ventilation and particularly upon matters concerning mine explosions asks me:

"Is it possible to find whitedamp with a lamp and live to tell the tale?"

Unless the experimenter is wearing a helmet the answer must be an emphatic, No. Any combustible gas, before its explosive point is reached, must show a cap upon the flame of a safety lamp; carbon monoxide as well as methane. But less than 2 per cent. of either gas cannot be detected by the average fire boss with the average safety lamp, and it requires some little time, granting the ability to see such small caps as this amount of gas produces, to make sure that one has a "showing" at all. Long before the fire boss is certain that he has a cap which may, by the way, be that of methane or monoxide as they are alike, he will have been overcome, and no aid being forthcoming, will die, and dying, cannot tell the tale.

And while "No" will be the answer of those who have had anything to do with this gas, particularly as one of the constituents of the afterdamp resulting from a dust explosion, there will be many of limited experience but much "book larnin'" who will hold the opposite. Let all such try the experiment of remaining for 3 minutes in an atmosphere containing but 1 per cent. of monoxide, breathing it in as rapidly as will a fire boss in making his rounds on the jump, and then tell us about it. Their experiences would make a very interesting addition to our knowledge on the subject. They must bear in mind, while making the test, that under actual working conditions the fire boss is breathing rapidly (as he has to hurry to make his rounds), and that he has unquestionably been subject for from 1 to 10 or more minutes to gradually increasing proportions of the gas so that when he reaches (if not exhausted long before) a point where the gas will show a cap, his blood is already partly saturated with it.

Those interested in this subject will find much of interest in Technical Paper 11, of the Bureau of Mines, by George A. Burrell. Mr. Burrell tells what he knows of his own knowledge and not what he has read or some one has told him. Better write the Bureau for a copy of this paper.

But, when all is said and done, just wherein lies the profit of all this discussion about monoxide? What difference does it make whether under certain conditions methane burns to dioxide and under others to monoxide, or whether monoxide may or may not be determined with a safety lamp? In all this plenteous flow of words we overlook the all-important fact that monoxide is always formed in fatal quantities by the burning, inflammation, or explosion (let the hair

splitters take their choice of terms) of coal dust, and that where monoxide formed from exploding methane has possibly killed its tens, monoxide from exploding coal dust has certainly killed its tens of hundreds. Those of us who have worn the helmet, who have seen the long row of silent forms, who have tried to comfort and aid the widow and orphan, know of our own bitterly acquired experience, that when coal-dust accumulations and coal-dust explosions have been finally prevented, the last word will have been said upon monoxide poisoning.

Old Timer

The Automobile at Coal Mines

The value of automobiles for coal mine officials whose duties require them to make frequent periodical and occasional emergency visits to several collieries has been thoroughly proved by a number of mining companies. The saving of time alone, not considering the advantage of quickly having the right man on the job, when he is most needed, quickly pays the cost of the automobile and its upkeep. When a man has general charge of one mine, an automobile, while useful, is in many cases a luxury, but when, as is frequently the case, an official has two or more collieries under his charge, it becomes a valuable economic proposition. If a manager, general superintendent, general foreman, or a mining engineer, having two or more collieries to look after has an automobile at his command, he can increase his efficiency by from 30 to 100 per cent., through the saving of time in traveling from colliery to colliery, and his consequent ability to spend more of his time at each mine. Naturally, under such circumstances, he can devote more time to many details, that otherwise are often neglected, through press of apparently more important matters, and the expert treatment of one or more of these details may, and frequently does, conduce to economy in cost of production, or greater safety to life and property. The quick transportation facilities afforded by an automobile, not only permit a general official to give more attention to each individual colliery, but they also make it possible for him to give intelligent direction to more collieries.

In times of emergency at coal mines—and those times are by no means infrequent—the ability of the general manager, general superintendent, general foreman, and mining engineer, or any one of them, to get to the mine quickly, often means the speedy remedying of bad conditions, the saving of more or less human lives, and the prevention of heavy monetary loss.

Many progressive coal mining companies are supplying automobiles for those of their officials whose duties require them to direct operations at two or more mines, and they have found it pays.

As an instance of the value of an automobile in getting higher officials to a mine quickly, the writer can instance a recent case. He was making a call on a general manager of a large coal mining company. At the time of the call the general inside superintendent was in the manager's office. A telephone message to the manager announced a fire in the workings of a large colliery, 5 miles away. The automobile was summoned at once, and the manager and general inside superintendent were in it in less than 5 minutes. In 30 minutes they were at the mine. The right men were on the job. They were on it quickly. Proper measures were taken and the fire was soon subdued with comparatively trifling property loss, and no accidents to any of the employes. In this case time was important, and as is often the case, the danger increased in geometrical progression with the passage of each minute. The use of the automobile contributed to the prevention of the destruction of thousands of dollars' worth of property and the possible, indeed probable, loss of human life.

The above is but one instance proving the value of the automobile to mining officials in case of emergency. If every case that has occurred during the past 3 or 4 years could be tabulated it would make a strong argument in favor of the motor car.

There are, undoubtedly, many other instances unrecorded, because coal mine officials are not prone to boast of, or make public, narrow escapes in which serious troubles were overcome by simple, inexpensive methods directed by the right man.

The value of motor cars for the transportation of trained rescue corps with their apparatus from some central point to collieries where their services are required is recognized in Great Britain and by some of the larger coal mining companies in America, whose collieries are so located that one well trained rescue corps, if occasion requires, can be called in for service at several mines.

OBITUARY

DR. A. E. BARLOW

Dr. A. E. Barlow and wife, of Westmont, Quebec, Canada, lost their lives when the "Empress of Ireland" sank in the St. Lawrence River. He was a well-known Canadian geologist, who was so highly respected by his associates that he was made President of the Canadian Mining Institute. He was also a member of the American Institute of Mining Engineers, and attended the last annual meeting held February, 1914, in New York City. No one probably did more to further the interests of the Canadian Mining Institute than Doctor Barlow, and for this reason and his kindly manner to all, the Institute will keep his memory alive.

It is reported that oil shales have been found in South Africa which yield from 60 to 80 gallons of crude oil per ton.

Answers to Examination Questions

Questions Asked at an Examination for Foreman and Assistant Foreman, Held in Pottsville, Penna., May 25, 1914

Ques. 1.—What are the qualifications for a mine foreman and assistant mine foreman to fully fit them for the position, and what are their duties?

Ans.—The applicant for either position must pass a satisfactory examination as to his knowledge of mining, must have had 5 years' practical experience as a miner, and must be of good conduct, capability, and sobriety.

Under the supervision of the superintendent, the mine foreman has charge of the underground workings and everything relating thereto, and his duties are to see that the coal is safely and economically mined and that the provisions of the mining law are carried out. The assistant foreman is under the direction of the mine foreman, and acts for him when he, the foreman, is absent or otherwise engaged. His chief duties, however, are those of a fire boss in testing for gas and in supervising the ventilation.

Ques. 3.—What duties does the law impose on the mine foreman and his assistants?

Ans.—They must examine all abandoned and gaseous parts of the mine which are accessible at least once a week; must remove all danger existing therein; and must enter the results of their examination in the report book, and must sign the same.

Every morning within 3 hours previous to the men going to work, they must examine with a safety lamp all working places, traveling roads, etc., which might be dangerous, and must mark on the face the date of the examination as evidence thereof. No man shall be allowed to enter his working place until the mine as a whole and the working place in particular has been reported safe. A record of these daily examinations must be entered in the mine report book and must be signed by the person making it.

They shall establish a station or stations at the entrance to the mine or at different points underground, beyond which stations no workman shall be allowed to go until the mine inby the same has been inspected and reported safe. The fire boss (or some one appointed by him or the mine foreman) shall remain on duty at the station to prevent persons passing beyond the same until the workings have been reported safe.

Every precaution shall be taken to ensure the safety of the workmen if the mine, or any part of it becomes dangerous by reason of accumulations of gas or from any other cause. All persons not required to assist in removing the danger must be withdrawn from the mine (or the dangerous part of it) until the workings have been made safe.

Locked safety lamps must be exclusively used in places approaching abandoned workings apt to contain explosive gas, or where, in general, explosive gas is present. Safety lamps are the property of the operator, who must employ a competent person to see that, immediately before being used, they are clean, safe, and securely locked. Unlocked lamps may be used by permission of the mine foreman. Where locked lamps are used, unauthorized persons shall not have a key to them; nor shall matches or other devices for striking a light be carried into the mine.

Where locked safety lamps are used no blast shall be fired without the permission of the mine foreman, or his assistant, who must examine the place and adjoining places to be sure that the shot may be safely fired before giving permission.

The foreman, or his assistant, must examine every working place at least every other day during the hours that the miners are or ought to be at work, in order to direct and see that the roof is securely propped, that all loose coal and slate is pulled down or secured, and that, in general, the place is safe to work in.

The mine foreman, or some one appointed by him, shall daily examine all slopes, shafts, main roads, traveling ways, signal apparatus, pulleys, and timbering, to see that they are in a safe and efficient condition.

Ques. 4.—On what scale does the law require the maps of the mines to be made, and how are the distances represented: Horizontally, or as measured on the various pitches?

Ans.—Mine maps are drawn or projected on the scale of 100 feet to 1 inch. All distances measured on the pitch are reduced to the horizontal by multiplying the slope distance by the cosine of the angle of pitch, and are so mapped.

Ques. 5.—What are the conditions which should be taken into consideration in determining the width of breasts and pillars? Should they be of equal width under all circumstances?

Ans.—The thickness of the seam and its depth below the surface, as well as the character of the coal and of the roof and floor and the pitch of the seam, must be considered in determining the relation between the width of breast and thickness of pillar. Thick pitching seams under heavy cover, particularly if the coal, roof, or floor are soft, require thicker pillars (and, consequently, narrower rooms) than those seams in which the opposite conditions prevail.

From the foregoing, it follows that uniformity in width is impossible.

Ques. 6.—If the map shows a distance of 200 feet between the gangway and the land line parallel to the gangway, how far can a breast be driven without crossing the line, where the pitch is 48 degrees?

Ans.—The distance measured on the pitch is equal to the horizontal distance as scaled from the map divided by the cosine of the angle of pitch, hence, Length of breast $= \frac{200}{\cos 48^\circ} = \frac{200}{.66913} = 298.9$ feet, nearly.

Ques. 7.—What is natural ventilation, and is such reliable for mining purposes? Why?

Ans.—Natural ventilation is a circulation of air produced by causes independent of mechanical means, such as wind blowing over the mouth of a shaft or water falling down the same, the natural heat of the rocks enclosing a seam in winter, and their cooling effect in summer. The chief producing cause, however, of natural ventilation is the difference in weight of a column of air within and that of an equal column of air without the mine. This difference in weight causes a difference in pressure between the air within and without the mine, resulting in a flow of air from the area of high toward that of low pressure.

As the difference in weight between the air inside and outside the mine is due to their different temperatures, and as the outside temperature varies from season to season, from day to day, and even from hour to hour, it is apparent that the direction and volume of a natural circulation is constantly changing, and that, when the temperature within and without the mine are the same, there will be no circulation at all. For these reasons, natural ventilation is not to be depended upon.

Ques. 8.—Suppose a mine has two openings, one 60 feet higher elevation than the other on the surface; the temperature of the air outside being 75 degrees, and that inside the mine being 50 degrees, would there be a current of air passing; and if there was, in what direction would it pass?

Ans.—Suppose one shaft was 160 feet deep and the other 100 feet (the difference in height being 60 feet), it is apparent that a column of cool air 160 feet high at 50 degrees will weigh much more than a column of warm air 100 feet high at 85 degrees. Hence, there will be a flow of air from the higher to the lower elevation; that is, the air will enter the mine through the 160-foot shaft and leave it by the 100-foot shaft.

Ques. 9.—When a fan is exhausting the air from a mine, how does it produce ventilation? State also how a forcing fan produces ventilation.

Ans.—The exhaust fan acts by reducing the pressure within the mine, so that the outside air flows into the workings through the intake or downcast shaft. The force fan increases the pressure in the mine so that the air within the workings is forced out of them, outside air entering through the fan.

Ques. 10.—What are the provisions of the law regarding doors in mines?

Ans.—All doors must be hung and adjusted so that they will close automatically. Unless the door is of the self-acting type, a constant attendant must be provided to see that the doors are open only long enough for a person or trip to pass. Main doors must be arranged in pairs so that when one is open the other is closed, in order that a temporary stoppage of the air-current may be prevented. An extra main door, kept standing open and out of reach of accident, must be provided, and must be so arranged that it can be immediately closed in event of accident to either regular main door. The framework of main doors must be substantially secured in stone or brick, laid in mortar or cement, unless the state mine inspector gives written permission to the contrary.

Ques. 11.—What material, in your judgment, should be kept on hand at fiery or gaseous mines to meet emergencies likely to arise from explosions of firedamp?

Ans.—Among the materials that should be kept on hand, are brattice boards, canvas, props, nails, and tools for rebuilding brattices and restoring the ventilation; fire extinguishers, lengths of perforated pipes, hose, etc., for putting out any blaze that may have been started; and oxygen helmets, emergency medical cases with supplies, pulmotors, etc., to be used in exploring the mine and in rescuing and in rendering first aid to any men who may have been caught in the explosion.

Ques. 12.—What dangers are probable in a mine after an explosion of firedamp; and what precautions should be taken upon entering it?

Ans.—The almost certain danger after a mine explosion is the presence of afterdamp. If the afterdamp contains a large amount of carbon dioxide, death by suffocation will follow; if it contains carbon monoxide even in very small amounts, poisoning will ensue. There is further danger from falls of roof or coal loosened by the explosion, as well as of a second explosion of gas that may have been liberated since or as a result of the first explosion; which gas may be ignited by the lights of the exploring party, by a mine fire, etc.

The ventilation should be restored, beginning at the foot of the shaft and proceeding inward therefrom toward the face. While this is being done, no one should be allowed to

go in advance of the air for a greater distance than is necessary to place the prop or props to which the brattice boards or brattice cloth are to be immediately nailed. As the brattices are built, the roof and sides should be timbered where necessary or the loose material should be taken down.

Ques. 13.—Describe fully your method of examining a mine for firedamp, beginning with your preparation before entering the mine, and explain each step taken until the examination is completed and the report made to the proper officials.

Ans.—At the lamp house, secure a safety lamp and see that the gauze is clean and perfect, that the lamp is properly put together so that it does not leak, that it is trimmed, filled with oil or naphtha, and properly locked. At the fan, examine the steam gauge, pressure gauge, and revolution counter to see if the fan is operating under normal conditions; examine the exhaust air for the possible presence of smoke; see if the bearings are cool and well oiled, and note if the fan is pounding or is running evenly. At the foot of the shaft, estimate as closely as possible if the usual quantity of air is entering the intake, and read the water gauge if a permanent one is installed.

On the way to the working places examine all cavities in the roof for gas, look for falls of rock, broken timbers, loose slate, and any other thing that might require attention on the part of the foreman.

At the mouth of the first working place on each gangway reduce the height of the flame of the safety lamp to that used for testing and proceed up the breast to the face, noting the place where gas is first found, its depth, etc., and mark the date of the examination on the face if it is possible to reach; otherwise at the nearest safe point thereto. The second and succeeding rooms may be entered by way of the crosscuts. If a dangerous amount of gas is found in any breast, place a marked board or other means of indicating the fact across its mouth. In each breast, in addition to testing for gas, examine the roof and sides to see if they are safe.

After completing the examination of the workings, return to the station and report to the foreman. If the workings are safe, the assistant may go home or attend to such duties as may be required by the foreman. If the workings are gaseous, the assistant or some one deputized by him or by the foreman must remain at the station until the workings have been made safe, in order to prevent any one passing the danger line. The condition of the working places not only with regard to the presence or absence of gas, but also in regard to other dangerous features must be entered in the mine record, dated, and signed.

Ques. 14.—What device would you use to remove gas from holes and cavities in the roof of gangways or breasts?

Ans.—A canvas brattice may be built across the place outby the cavity with its upper part so arranged that the air-current is forced into the hole through a wooden pipe, into the hole through a wooden pipe at the outer end of which a small fan or paddle is turned by hand; or the brattice having been built across the place as before, air may be drawn into the hole through the wooden box, one end of which is on the outer side of the brattice and the other end inserted in the cavity.

Ques. 15.—What are the requirements of the law regarding measuring the ventilation, and how can the air-currents be measured?

Ans.—The quantity of air in circulation must be measured by the foreman or his assistant once a week at the intake and return airways, at or near the face of each gangway, and at the nearest crosscheading to the face of the inside and outside breast where men are employed. No headings shall be driven more than 60 feet from the face of any breast. A record of the air measurements must be entered in the mine report book, and a report thereof sent to the district inspector before the 12th day of the month of those of the preceding month, together with a statement of the number of persons employed in each district. Air measurements are to be made with an anemometer or some other efficient instrument.

Ques. 16.—What quantity of air is passing through an airway 7 feet 4 inches high, 11 feet 9 inches wide, when its velocity is 434 feet per minute?

Ans.—Since 4 inches $= \frac{1}{3}$ foot, and 9 inches $= \frac{3}{4}$ foot, the area of the airway $= 7\frac{1}{3} \times 11\frac{3}{4} = \frac{22}{3} \times \frac{47}{4} = \frac{1034}{12}$ $= 86\frac{1}{6}$ square feet.

Quantity = area × velocity $= 86\frac{1}{6} \times 434 = 37{,}396$ cubic feet per minute.

Ques. 17.—In a mine employing 420 persons, how many splits of air does the law require; and how much air is required for this number of persons?

Ans.—Not more than 75 persons are allowed to work in any one split; consequently, 420 persons will require $420 \div 75 = 5+$, or 6 splits, since a fraction of a split is impossible. The law further requires that each person must be supplied with 200 cubic feet per minute of air; hence, 420 persons will require $420 \times 200 = 84{,}000$ cubic feet of air per minute.

Ques. 18.—In a mine ventilated by one current of air, what would be the effect of splitting the current into several separate currents? Explain how it can be done and why such a result is obtained.

Ans.—The effect of splitting the air is to secure a larger volume for the same power and at a less velocity. At the same time the mine is divided into a series of districts in which the quantity of air in circulation can, be within limits, decreased as needed; pure air is supplied to each district, since the foul air from each passes directly to the return instead of passing along the entire working face, and in event of an explosion in one district, its effects are not so apt to be communicated to other parts of the mine.

The splitting of the air is accomplished by the proper placing and use of devices known as doors, regulators, and overcasts. Doors are employed to cause the air-current to follow some other route than that which it would naturally take; regulators are openings in brattices built across a gangway, and having less area than the gangway they increase the friction of the air passing through the airway, thereby causing a greater volume to pass through another airway in which there is no regulator or one with a larger opening, and, consequently, offering less resistance to the passage of the current; overcasts are airways built of lumber, brick, concrete, etc., by means of which one current of air may be carried over another without the mixing or intermingling of the two.

(To be concluded in the August issue)

BOOK REVIEW

A review of the latest books on Mining and related subjects

Engineering Geology, by Heinrich Ries, Ph. D., Professor of Economic Geology in Cornell University and Thomas L. Watson, Professor of Economic Geology in the University of Virginia and State Geologist of Virginia. The book contains 672 pages, 6 in. × 9 in., 225 figures in the text and 104 plates comprising 175 figures. This book is the result of some years of teaching in a special course in geology, as applied to engineering, given by the authors in their respective universities. It gives those fundamental principles of geology which relate to engineering problems. The important feature of common rocks, so far as the engineer is concerned, relates to their use for building stone, and other adaptability to certain phases and construction work, such as fuels, pumps, etc. Familiarity with such materials as fuels, clays, cement rocks, etc., is also necessary. Throughout the book the authors have emphasized the adaptability of certain rocks for certain purposes and their economical values. Although this book was intended primarily for civil engineers, it will also prove helpful to others interested in applied geology.

The price of the book bound in cloth is $4 net, and can be obtained from John Wiley & Sons, Publishers, 432 Fourth Avenue, New York.

Chain Grate Stokers, and Steam Superheaters, are the titles of two books of 80 and 64 pages, respectively, recently issued by the Babcock & Wilcox Co., 85 Liberty Street, New York. While primarily these are descriptions of stokers and superheaters of that company they contain much valuable information on the subject of steam and combustion. They are bound in cloth, printed on high-grade paper, and the illustrations are of the highest quality.

Illinois Coal Mining Investigations.—In studying the conditions under which coal is mined in Illinois the Illinois Coal Mining Investigations, a cooperation between the Department of Mining Engineering of the University of Illinois, the State Geological Survey and the United States Bureau of Mines, has divided the state into eight districts, in order to group together mines operating under like physical conditions. Bulletin 4, Coal Mining Practice in District VII, by S. O. Andres, describes methods of mining in the largest of the districts. District VII comprises Bond, Clinton, Macoupin, Madison, Marion, Montgomery, Moultrie, Randolph, St. Clair, Shelby, and Washington counties, together with that portion of Perry County west of the Duquoin anticline and those portions of Christian and Sangamon counties in which Bed 6 of the Illinois Geological Survey correlation is mined. This Bulletin has 34 illustrations, many of which are flash-light photographs of various phases of the mining of coal, and the text describes in detail mining operations in the district, giving the costs of each step in the progress of coal from the working face underground to the tipple on the surface.

Copies may be obtained from the Illinois Coal Mining Investigations, 126 Natural History Building, Urbana, Ill.

West Virginia Geological Survey.—There have just been issued two new publications by the West Virginia Geological Survey, Morgantown, W. Va.

(0) "Detailed Report on Kanawha County," 679 pages + XXVIII, containing 38 half-tone plates and 14 figures in the text; also a case of three maps covering the soils, topography, and geology of the county separately. In addition to the description of the Kanawha coal series and all the geologic features of the county, the geologic map gives the structural contours on the Pittsburg coal horizon north from the Kanawha and Elk rivers, and on the Kanawha and Black Flint south and east of the Elk and Kanawha rivers, as also the location of the anticlines and synclines, showing their relations to the several oil and gas pools of the county. Price, $2, delivered. Extra geologic maps, $1 each; topographic, 50 cents each.

(17) "Revised Edition, Coal, Oil, Gas, Limestone, and Iron Ore Map," issued February 1, 1914. It contains a thorough revision of the coal, oil, and gas developments, several anticlinals being added and others corrected from later observations. The names and addresses of 918 coal companies operating in the state are given by counties, as well as the locations of their mines. The names of many new towns, post-offices, etc., are added, and the valuable iron ore deposits of the state are also indicated on this map, and all the special features of previous editions corrected and brought up to date, showing the approximate areas of the several coal series, as well as the oil and gas pools. Scale 8 miles to the inch. Price, by mail, 50 cents each, but in combination with other publications, write for prices to W. Va. Geological Survey, P. O. Box 448, Morgantown, W. Va.

NEW MINING MACHINERY

Coal Preparation on the Marcus Screen

*By J. V. Schaefer**

Keen competition has driven coal operators to great extremes in the cleaning and preparation of coal. One of the angles which this effort has taken has been in the direction of hand picking the larger sizes.

The demand for effective picking in connection with screens, with a view to using the simplest possible devices and eliminating the complexity of the machinery, resulted in the introduction into the United States in December, 1912, of the Marcus patent picking table screen, a device which had its origin in Germany, where it was primarily used as a conveyer.

The first Marcus screen installation was at Coalwood, W. Va., in December, 1912. This was followed in June, 1913, by an installation at Centralia, Ill., at the mine of the Marion County Coal Co. From that time installations have multiplied until Marcus screens are in use in Pennsylvania, West Virginia, Eastern Kentucky, Western Kentucky, Ohio, Indiana, Illinois, and Colorado.

*Vice-President, Roberts and Schaefer Co.

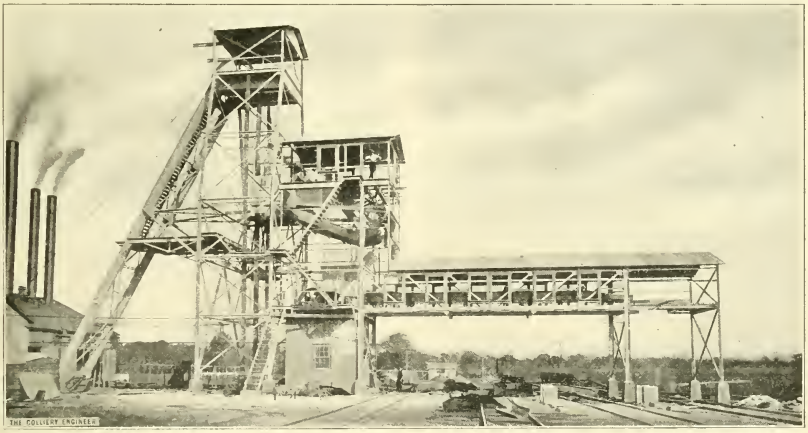


Fig. 1. Marcus Screen at Mine of Paradise Coal Co., DuQuoin, Ill.

Fig. 1 shows a typical installation of a Marcus screen at the shaft mine of the Paradise Coal Co., at DuQuoin, Ill. The usual head-frame with its self-dumping cage and weigh hopper will be recognized, but the form of building to which the coal trade is accustomed, viz., an inclined train shed taking the approximate line of the inclined shaking screen, is conspicuously absent. The weigh hopper discharges into a receiving hopper so that the entire contents of a pit car can be disposed of at once and the weigh hopper prepared to receive the succeeding charge. The coal, instead of being discharged with a rush upon the screen, is delivered from the receiving hopper by an automatic feeder, in a continuous stream to the Marcus picking table screen, which is made very much along the lines customary for shaking screens, but standing perfectly level. The motion of this screen is a peculiar one; it starts from a period of rest, moves forward at a steadily accelerating speed, then returns with a quick motion, the effect being that while the screen oscillates the coal travels forward

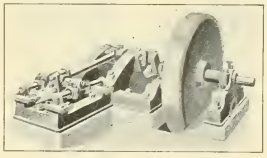


Fig. 2. Driving Machinery

uninterruptedly. The driving machinery for the screen is shown in Fig. 2.

This so-called driving head is placed upon a concrete foundation and takes all the shock and vibration due to driving the screen. In Fig. 1 it will be noticed that this foundation built in the form of a house, with doors and windows, contains the motor that drives the screen.

Fig. 3. Marcus Screen as Picking Table

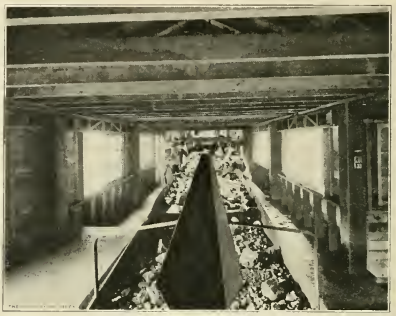


Fig. 4. Marcus Screen and Rock Carrier

In Fig. 3 is shown a Marcus screen in operation at the mine of the Marion County Coal Co., Centralia, Ill. This screen covers four tracks, making 6-inch lump, 3-inch egg, 1½-inch nut, and slack. Each size drops through the holes in the upper deck and is carried forward on the closed lower deck to the discharge point, where by means of the gate it may be discharged to chutes leading to the respective cars. At the moment the photograph was taken, this screen was handling at the rate of 300 tons per hour, and this time the pickings were thrown upon the floor. Later a rock carrier was provided onto which the pickings could be thrown and carried forward over the main line and disposed of.

Fig. 4 shows an installation at Milburn, W. Va., where the rock carrier is shown. It will be noticed that this rock carrier is a trough attached directly to the screen, oscillating with it, and the material thrown into this trough is carried forward in the same manner as the material is carried on the deck of the screen.

The lump coal at the Paradise Coal Co.'s plant is lowered into open cars by means of a loading boom, while the other sizes of coal are deposited into the railroad cars by means of the chutes especially designed for loading coal without breakage.

Some of the merits of the Marcus screen are:

First. It is an effective sizing screen which, because of its being level, can be placed low down so that the discharge from the screen to the railroad cars can be made short, and breakage reduced to a minimum.

Second. It is supported by means of roller bearings and the method of holding its driving gear on a solid foundation permits placing the screen very substantially, and in such a way as to impart no vibrations to the tipple structure, so that the whole installation is substantial and durable.

Third. The screen being level, it can be placed in a convenient building where all parts are readily accessible and where plenty of space and light can be provided so that all parts of the screen and the operations can be watched and taken care of.

Fourth. It is very much superior to the usual form of picking table consisting of a moving apron conveyer, because all the small coal is dropped through the upper deck and carried forward on the lower deck where it is out of the way and the pickers have the lump coal all spread out before them with no small coal to conceal the refuse to be picked out. This is shown in Fig. 3 on the upper deck where the men are picking.

Fifth. Again, it is an especially effective picking table for the reason that no space is lost at the side. Men standing on either side of the 6-foot screen can readily reach to the center, whereas with the apron conveyer type of picking table it is difficult for men standing on either side to reach across more than a 4-foot screen.

New Wing Turbine Blower

The reader, at first glance, might wonder why a new type of turbine blower should appear in a coal paper. If he thinks twice he will remember that the poorest coal brought out of mines is used under the boilers at mines and that artificial draft is required as a rule for its combustion.

The L. J. Wing Mfg. Co., of New York, have designed the turbine blower, shown in section in Fig. 5, for just such purposes, and as a matter of fact they are used by the Delaware, Lackawanna & Western Railroad Coal Department, also by

the Delaware & Hudson Co.'s Coal Department. The Wing company have adopted an expanding discharge casing which makes it possible for the fan to deliver more air at higher pressure with the same speed and size of fan, and with less power than can be obtained with an ordinary straight cylindrical casing.

The fan and turbine are mounted on a steel shaft with ball bearings each side of the turbine, where the exhaust steam or water does not enter them. Every part of this blower has been designed to meet and eliminate conditions that have proved a hindrance to other turbine blowers for creating artificial boiler draft. The nozzles, steam chest, rotor fan, and casing have been specifically designed to perform certain functions in definite predetermined ways. Turbine blowers are intended to replace argand blowers and in so doing improve on the combustion of poor boiler fuel at mines, and of good fuel at industrial plants.

Cylinder Lubricants

The name "Petroleum" is derived from two Greek words, petros (a rock) and oleum (oil), thus meaning rock oil. Its origin is a much-disputed question, and many theories have been advanced to account for its existence and formation. From the knowledge now available it seems most probable that it was formed by the decomposition of animal matter.

Petroleum is essentially a hydrocarbon body of a most complex composition, which varies greatly in different localities. While carbon and hydrogen are the essential constituents, other elements, such as nitrogen, oxygen, sulphur, and sometimes gold and arsenic are included.

The process of refining is one of distillation. The usual procedure is to run the crude oil into large tanks kept warm by steam pipes, and to allow it to stand for some time to permit the solid matter to settle. The oil is then run into the still and subjected to distillation.

As the vapors leave the still they are passed through a condenser and caused to flow, first into one tank, and then into another. The number

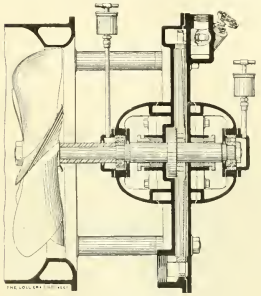


Fig. 5 Wing Turbine Blower

of these tanks, and the number of divisions of the distillate being determined by the kind of products desired.

Usually five divisions are made; in which case the products are naphthas, burning oils, lubricating oils, paraffin wax, and coke. Each of these products except coke is then refined and subdivided still further.

Cylinder stocks are products obtained from crude petroleum. The refining process for the production of these stocks is similar to that described above, except that superheated steam is introduced, and the divisions are different. After the napthas, burning, and light lubricating oils have been driven off, the balance, or residuum is drawn and strained to free it from all gritty matter, and sometimes refrigerated to eliminate any paraffin, after which it is ready for the market as dark, or steam refined cylinder stock. Sometimes it is filtered through charcoal, making it lighter in color. It is then sold as filtered or extra filtered stock.

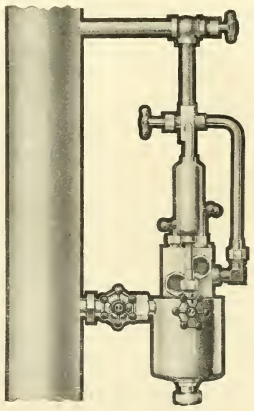


Fig. 6 Cylinder Lubricator

These stocks are heavy and thick, in fact most of them cannot be poured from a bottle unless heated. They also possess a very high fire test and viscosity—the highest of any of the products made from crude petroleum. Vaseline and petroleum jelly are obtained from them, but they are principally used in the manufacture of cylinder oils, greases, and other high-grade lubricating products.

In making cylinder oils, the stocks are compounded with certain percentages of neutral oils, animal oils, or fats.

Neutral oils are made from the light lubricating oils mentioned above. They are light and thin, and have a much lower viscosity, and about 200 degrees lower fire test than good cylinder stocks. They are added to cylinder stocks to thin them down, so the resulting oil may be handled in the ordinary manner, and incidentally to cheapen the product.

Animal oils used are tallow, lard, and neatsfoot oils, and degras or wool fat. These ingredients solidify at a comparatively high temperature, and are better in fire test, although not so high in viscosity as the neutral oils. Their purpose is to assist the cylinder oil to withstand the action of the water in steam.

Cylinder grease, as it is now known, was invented, and developed to its present state of perfection by the Ohio Grease Co. who, in making their grease, take particular care to select the best cylinder stocks obtainable, and to accurately com-

pound with them a small percentage of acidless tallow oil and other high-grade ingredients. Neutral oils, and all other thinning, cheapening, and weakening products are left out.

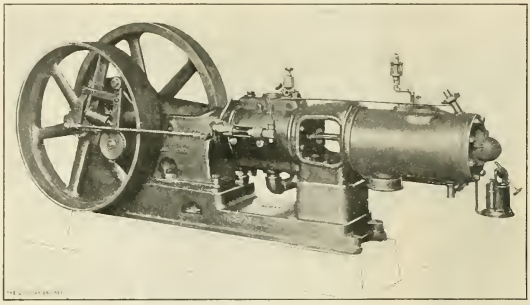


Fig. 7. Oil-Engine-Driven Air Compressor

The Ohio Grease Co. recognized the fact that the average lubricator does not properly atomize the lubricant and obtained patents on a lubricator that performs this function perfectly. This instrument shown in Fig. 6 is made in both up-feed and drop-feed styles and is loaned free for the purpose of feeding Ohio cylinder grease. The combination of this very high-grade lubricant with a perfect system of application has been productive of exceedingly good results.

Oil-Driven Air Compressor

The increased use of low-grade oil fuel for power purposes has led to the design, by the Ingersoll-Rand Co., of the oil-engine-driven air compressor.

This is of the direct-connected straight-line type and somewhat resembles in this respect, as well as in the design of the air end, the company's standard line of small compressors.

The main frame is designed for a splash system of lubrication, and is of the wholly enclosed type, provided with removable covers.

The feature of greatest interest, in this machine, is the design of the driving end. This, as can be seen from Fig. 7, consists of a single oil engine cylinder set behind the air cylinder and directly connected by means of an extended piston rod to the air piston. It follows in general design, the hot-bulb engine, which is really a development of the Diesel engine, and combines a high thermal efficiency with simplicity of construction and far less complication in details of design; there being an entire absence of auxiliary air compressors, etc., this, combined with a lower working pressure, makes an ideal engine for compressed air service.

The power cylinder is of the single-acting, two-cycle type. It is water-jacketed, provided with an efficient system of lubrication, and is supported by a heavy distance piece, reaching to the foundation and bolted to the air cylinder. It is fitted with a torch for heating the ignition bulb preliminary to starting. After the compressor is under way this torch is dispensed with.

The fuel is automatically injected into the combustion chamber, by means of a small pump on the side of the frame, operated by the main shaft. It enters in the form of a finely atomized spray and is immediately ignited by the hot bulb, dispensing entirely with electric sparking devices, batteries, etc. The stroke of the fuel pump is regulated by a centrifugal governor located in the flywheel; thus regulating the amount of fuel injected into the cylinder in proportion to the load. This is supplemented by a regulating device, on the intake to the air cylinder of standard design.

The operation of this machine is accompanied by none of the losses common to the average two-cycle gasoline engine, in which part of the incoming charge follows the exhaust gases through the outlet ports and is wasted. This is due to the fact that the fuel is not vaporized by an outside agency and introduced with the air used for scavenging, but is injected directly into the cylinder, at the end of the compression stroke, as already mentioned.

This means that pure air is used during the scavenging period of the stroke, consequently the inlet and outlet ports can be so arranged that more thorough scavenging is afforded without any loss of fuel. The absence of carburetor, with its needle valves, springs and delicate adjustments which have to be constantly changed to suit atmospheric conditions, is an advantage which cannot be over-estimated.

Another feature of this engine is the introduction of a small quantity of the water from the cylinder jacket, into the combustion space. This water performs the function of regulating the temperature in the cylinder, thereby preventing an undue rise in temperature of the piston, etc. causing disassociation of the fuel. It reduces the maximum pressure in the cylinder, at the same time slightly increasing the mean effective pressure, making a smooth running and highly economical machine. The amount of water injected is regulated according to the load on the compressor.

The machine is at present made in but one size with an actual capacity, when running at 325 revolutions per minute, of 66 cubic feet of free air at 100 pounds pressure, and 73 cubic feet at 80 pounds pressure. The fuel consumption at this speed, and under average operating conditions is about 2.2 gallons of kerosene per hour. It is adapted to run on either kerosene, fuel oil, or

distillate. It weighs complete 3,000 pounds and requires a floor space of 8 ft. 10 in. × 2 ft. 5 in.

Jeffrey Wagon Loader

The Jeffrey wagon loader consists of a truck on which is mounted a bucket elevator that is driven by a gasoline engine or an electric motor. The machine will handle coal, crushed stone, sand, gravel, and other material from ground storage to wagons. It is provided with a power device for moving the machine to any designated place where it can conveniently load the material into wagons. The machine can be fed into a storage pile as desired while the elevator is in motion. The elevator ladder is made so that it can load from the ground or from a pile without interfering with the adjustments of the driving chain. Provision is also made for screening the material handled, but when a screen is not required it is covered with a veil plate.

Fig. 8 shows the machine loading a wagon. It is self-propelling and can be moved over rough roads without upsetting if ordinary care is used. The machine can be handled by one man and will care for material 6 inches in diameter. It is claimed that it can load 1 ton of coal in 1 minute, or 2 tons of sand, gravel, etc. It eliminates idle labor between wagons which are to be loaded, and lessens generally the cost of labor.

TRADE NOTICES

Electric Storage Batteries.—In connection with the increasing use of storage-battery locomotives, a bulletin recently issued by the Electric Storage Battery Co., of Philadelphia, is of interest. This company manufactures several different batteries but for mining service recommends especially the Ironclad-Exide battery which is especially described in Bulletin No. 146. This form of battery has been used by the General Electric Co., the Jeffrey Mfg. Co., and others, for the operation of storage-battery mine locomotives, and the bulletin is of interest to all having to do with such locomotives.

H. W. Johns-Manville Co.—The Duluth office of the H. W. Johns-Manville Co. has moved to No. 327 W. First Street, in order to take care

Fig. 8. Jeffrey Wagon Loader

of its increased business. The new office is on the ground floor, with windows for the display of J-M asbestos roofing, pipe coverings, packings, sanitary specialties, auto accessories and other products of this company.

The Lufkin Rule Co. announces the issuing of a new catalog, No. 9, of 110 pages devoted exclusively to Measuring Tapes and Rules. In addition to measuring tapes and steel rules, which the company has manufactured for 25 years, they now make a complete line of folding boxwood, and flexible spring-joint wood rules. Copies of the new catalog will be sent on application.

Roberts and Schaefer Co.—The W. G. Duncan Coal Co. have awarded contracts to the Roberts and Schaefer Co. for two Marcus patent coal tipples for installation at Greenville and Luzerne, Ky. Also the Chicago Great Western Railway Co. has contracted for three 100-ton capacity, reinforced concrete, counterbalanced bucket (Holmen type) locomotive coaling plants for installation at St. Joseph, Mo.; Carroll Iowa; and Kenyon, Minn.; also a 50-ton capacity frame coaling station at Red Wing, Minn. In addition they have an order for two 100-ton concrete stations from the same design for installation at Blenheim, Ont., and Port Huron, Mich., for the Pere Marquette Railway. The plants are all alike and equipped with 100-ton weighing features.

Cold-Water Paint.—The experience of a large western mining company suggests the advisability of using cold-water paint both under and above ground, in order to render conditions less dangerous for those who work in semidarkness, and also as a fire retardent and medium for improving sanitary conditions. There are some underground workings lighted fairly well in places but in other parts the miners are dependent on the lamps they carry. Other places in the mine where this J-M cold-water paint can be used to advantage are the landings and the pump stations where it will help the men in performing their duties by reflecting light. In the breaker it is claimed that cold-water paint makes for economy, as here the employes must have plenty of light.

The J-M cold-water paint comes in dry powder form, is easily mixed and possesses unusual whiteness. It is remarkably durable and costs little more than ordinary lime wash. In addition to its other qualities, this paint is a fire retardent, therefore a heavy coating on timbers would be an aid in controlling a fire. As it is also sanitary, its use both in the mine itself and in the various buildings connected with the mine is desirable.

Standard Safety Lamps and Parts. The American Safety Lamp and Mine Supply Co., of Scranton, Pa., has added a new department to its business. It proposes to furnish duplicate parts for standard lamps and also for those lamps made by concerns now out of business. Some operations which have bought foreign lamps or lamps from concerns that are now out of business, or that have changed hands, will now have an opportunity to obtain duplicate parts. The American Safety

Lamp and Mine Supply Co. has issued a catalog which shows the standard makes of lamps that can be secured at all times from a permanently established company.

Delay Blasting Caps.—The trouble with the old style delay electric blasting caps was the frequent failure of the ignition charge to light the delay device. This trouble has now been overcome by the Du Pont Co., which makes them with copper wires only and in three delays easily distinguished by color of insulation on wires—No Delay, red insulation—First Delay, red insulation—First Delay, white insulation—Second Delay, blue insulation.

In tunnel or shaft sinking, the No Delay, being instantaneous, are used in the cut holes; the First Delay are used in the relief or next set of holes to be blasted; the Second Delay are used in the rib holes. They may be satisfactorily used in wet work if not immersed in water for over one-half hour.

Delay electric fuse igniters consist of a copper tube about 2½ inches long. In one end is inserted an electric ignition device with copper wires for firing with blasting machines or power circuits. In the other end is crimped a piece of waterproof fuse, 2, 4, 6, 8, 10, or 12 inches long, according to the delay required.

To detonate high explosives or permissibles, nothing weaker than a No. 6 blasting cap on the fuse should be used.

To ignite blasting powder no blasting cap is necessary.

Of course, those with shortest length fuse should be used in the bore holes that are to be fired first, etc.

They should be used only in work that is dry or slightly damp.

Delay Electric blasting caps and Delay Electric fuse igniters require about 10 per cent. more electric current to detonate them than ordinary blasting caps.

When detonated by means of a blasting machine, they *must* be connected in *series*. When detonated by means of a power or lighting circuit, they may be connected in series, parallel or parallel series.

An Interesting Catalog.—The Ottumwa Iron Works, of Ottumwa, Iowa, has recently issued a catalog of electric and steam hoisting engines and mine equipment, that is a good example of what a catalog ought to be. The illustrations show the different machines in the plainest possible manner, while the descriptive matter is directly to the point. The line is very complete and is the result of long experience.

New Electric Plant.—Among others, the General Electric Co. has furnished electric mining machinery to the following companies:

The Clinchfield Coal Corp., Dante, Va., three 5-ton, seven 6-ton, and five 16-ton mine locomotives, of 48-inch gauge and for 250-volt current. The Davis Coal and Coke Co., Thomas, W. Va., a 2,500-kilowatt Curtis turbogenerator with 50-kilowatt induction motor-generator set, two 300-kilowatt rotary converters and six 110-kv-a. transformers, also four 10-ton and six 6-ton electric mine locomotives. The Jefferson Coal Co., Coal Glen, Pa., two 5-ton electric mining locomotives. The Logan Mining Co., Logan, W. Va., 5-ton electric mining locomotive.

Catalogs Received

The American Safety Lamp and Supply Co., 1321-1333 Capouse Avenue., Scranton, Pa. Miners' Safety Lamps, 36 pages.

Bristol Company, Waterbury, Conn. Bulletins Nos. 188-189, Bristol's Recording Differential Pressure Gauges and Recording Flow-Rate Meters, 2 pages.

Ottumwa Iron Works, Ottumwa, Iowa. Catalog No. 30, Electric and Steam Hoisting Engines and Mine Equipment, 115 pages.

Hess-Bright Mfg. Co., Philadelphia, Pa. Hess-Bright Ball Bearings for Axle Lighting Generators, 12 pages.

American Concentrator Co., Springfield, Ohio. New Century Disintegrating and Washing Screen, 12 pages.

Electric Storage Battery Co., Allegheny Avenue and 19th Street, Philadelphia, Pa. The "Ironclad-Exide" Battery for Storage Battery Locomotives, 18 pages.

Ohio Brass Co., Mansfield, Ohio. Catalog No. 14, Overhead Materials, Rail Bonds, Car Equipment Specialties, and High-Tension Porcelain Insulators, 606 pages.

Hazard Mfg. Co., Wilkes-Barre, Pa. Price List No. 54, Hazard Rubber Covered Wires, 28 pages.

Cyclone Drill Co., Orrville, Ohio Cyclone Hollow Rod Tools, 72 pages.

Jeffrey Mfg. Co., Columbus, Ohio. Jeffrey Portable, Self-Propelling Wagon Loaders, 7 pages.

Link-Belt Co., Chicago, Ill. Wagon and Truck Loaders, 31 pages.

Morgan-Gardner Electric Co., Chicago, Ill. Catalog No. 57, Mining Locomotives, 40 pages.

Baldwin Locomotive Works, Philadelphia, Pa. Record No. 78, Locomotives for Industrial and Contractors' Service, 32 pages.

Carnegie Steel Co., Pittsburg, Pa. Steel Cross-Ties, Duquesne Rail Joints, Braddock Insulated Rail Joints, 72 pages.

L. J. Wing Co., 352-362 West 13th Street, New York, N. Y. Bulletin 17, Air Handling and Power-Plant Machinery, 21 pages.

Gun-crete Company, McCormick Building, Chicago. The Cement Gun and Its Works, 315 pages.

Automatic Reclosing Circuit Breaker Co., 197-199 North Front Street, Columbus, Ohio. Automatic Circuit Controllers, 12 pages.

Lunkenheimer Company, Cincinnati, Ohio. Lunkenheimer "Renewo" Valves, 12 pages.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Form No. 8011, "Little David" Riveting Hammers, 8 pages; No. 8011-1 Rivet Set Retainer for "Little David" Riveters, 4 pages; No. 4020, Leyner-Ingersoll Water Drills, 32 pages.

Bayley Mfg. Co., Milwaukee, Wis. Bayley Heating, Ventilating, Drying Apparatus, Blowers and Exhaust Fans, 96 pages.